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In re Application of : Georg Michael Ickinger  
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720 Hanna Bldg  
1422 Euclid Ave  
Cleveland, OH 44115

**PRELIMINARY AMENDMENT**

Assistant Commissioner for Patents  
Box PCT  
Washington, D.C. 20231

Dear Sir:

Applicant submits herewith a revised specification to be submitted for the specification filed with the declaration attached hereto. The original specification filed with the subject application corresponds to the English translation of the PCT counterpart application.

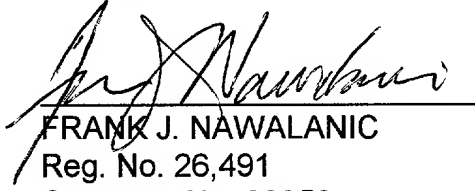
The substituted application is submitted to correct the English usage in the PCT specification and to add Sections to the application to conform to the CFR, such as the Description of the Drawings. The claims have not been changed but applicant may submit a second preliminary amendment directed to the claims. Because of the extensive grammatical language changes, a formal marked-up copy showing how the

original specification has been changed is NOT submitted. The undersigned is aware of the rule changes for amendments regarding a marked-up copy of the specification to show the changes made to the specification or to the claims. To comply with this rule, if compliance is required in this case, applicant submits the handwritten marked-up copy from which the Substitute Specification was typed which shows where the changes were made although not in the underlined and bracketed method.

If a more formal document is required, the Examiner is requested to contact the undersigned.

720 Hanna Bldg  
1422 Euclid Ave  
Cleveland, OH 44115  
(216) 696-8815

Respectfully submitted,

BY:   
FRANK J. NAWALANIC  
Reg. No. 26,491  
Customer No. 22052

09/936 039

**GEORG M. ICKINGER**  
**A-8010 GRAZ, AUSTRIA**  
**WEG ZUM REINERKOGEL 37**  
**TEL & FAX +43 316 676873**  
**E-MAIL: GMICK@PING.AT**



## **=STRUCTURE**

ATT.: TO WHOM IT MAY CONCERN

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# CERTIFICATE

I, Dipl.-Ing. Dr. techn. Georg Michael ICKINGER,  
certify that I am a German translator, who is fluent in English and German  
and that the attached document is a true and accurate English translation of  
the International Patent Application PCT/AT01/00003 filed 04 January, 2001  
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Georg Michael ICKINGER

**Georg Michael ICKINGER**

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**Method for Introducing Additives**

The invention relates generally to a method for introducing additives into flowing or fluidised media with specific application for plasticating processes although not limited thereto.

5 The spatially predetermined position of the additives in the flowing material, also called fluid bed, is obtained by controlling the pulsating injection. The introduction and exact dosing of additives, that is hardeners, dyes, gas producers and softener for instance, into a liquid plastic stream or metal stream for instance or the fluid bed of bulk material, such as powder, granules and pellets, is carried out by means of an injector. The invention is used in melting units, in hot channel  
10 systems, in tools, components of tools and injection moulding machines, extruders, injection moulding, pelletizing, burner and injection arrangements. The nozzle needle of at least one nozzle respectively is variable and highly precisely moved for the introduction by means of a device and in such a way that an additive is dosed exactly in relation to the volume flow of the medium and that a pulsating  
15 stream is injected into the medium flowing past the pulsating stream, by means of at least one well-aimed nozzle opening. The additives are dosed by means of a pressure that can be variably adjusted such as by pulse width and pulse frequency. The desired homogenous distribution is obtained by the penetrating injection jet during compounding for instance.

20

**BACKGROUND**

25 In US patent No. 4,474,717, by James W. Hendry, dated 1982, an injection of spatially predetermine position is disclosed, specifically, injection of a small portion of plastics without introducing inert gas (preloading) followed by sectional introduction of inert gas using frequencies from 4 to 100 cycle per second having a pressure of 300 – 1500 psi (2 to 10 MPa) into the continuous passing plastic

material. The result is a multi layered inside foamed structure. The present invention expands this method by applying injection technology used in the combustion engine technology. Reaching a more intensive penetration by higher pressure (40 to 200 MPa), higher frequency (100 to 1000 hz) and more exact dosing by controlled width of the pulses, frequency of the pulses and regulation of pressure using this technology. Various designs of nozzle and channels utilizing hydro-mechanical principles can be achieved for metal, bulk materials and highly viscous melts.

The following devices and methods are subject of previous solutions:

i) EP161614, WOLTON FRANK, 1985, shows a device for injection of certain amount of medium into the fluid stream. The adding of the additives happens by a charging pump which is activated by the flowing medium. Energetic mixing is not possible because of the small pressure difference.

ii) A device for adding additives into a liquid stream of high viscosity has been disclosed in US 5913324, SIGNER ARNO, 1997. By diaphragm the high shear forces of the medium with high viscosity is provided for the mixing to take place. A dosing is happening in the side stream and independent of the main stream.

iii) A device of adding additives after the plasticizing unit is shown in EP0432336, CLOMP PHILLIP, 1991.

iv) For the adding of additives after the plasticizing unit the following methods are known.

a) WO89053226, HETTINGA SIEBOLT, 1988 shows blowing in of air.

b) US4931236, HETTINGA SIEBOLT, 1989 shows spraying in of air/gas after the plasticizing to achieve a hose with a foamed layer.

c) DE1948454, BAYER, 1971 shows injection of a chemical gas producer after plasticizing unit.

A mixing by energetic injection jet stream and pulsing dosing is not the subject of the last named inventions.

v) A nozzle for application of glue by pulsation is shown in US 5934521, KOIKE KATSUHIKO, 1998. The nozzle-needle is activated by a pneumatic cylinder up and down, so that glue pours out in pulsing way. A mixing with a flowing medium passing by is not on purpose.

5 The pulsing adding of liquid and gas is state of the art in burner systems, airless jet systems and spraying systems (atomizers). The present invention is demarcating from these application by higher pressure of the liquid than 40 MPa and high energetic atomizing. This pressure is not possible with the nozzles used at this time. Only by electrical activated hydraulic servo valves in common rail  
10 technology can these pulsation be realized.

### SUMMARY OF THE INVENTION

a) General Description of the invention.  
15 The basic concept of the inventive method for introducing additives consist of obtaining intensive atomizing, mixing and deep penetrating of additives into the medium stream by using high kinetic energy of the additives and exact timed pulsing and exact pulse width using appropriate injectors.

The exact dosing of the additives is obtained by regulation of the operation  
20 parameters of introduction for instance pressure, frequency, pulsing width, etc.

The state of the art of combustion engines using the "common rail" injection technology is utilized. The flexibility of this system by modifying the operating parameters is the highlight of this technology in comparison to the present mechanical operated injection methods because there is injection nozzle, etc. The  
25 common rail is loaded with fuel being pressurized up to 200 MPa and supplies the injector with this constant pressure. Electronic controller activating solenoid and piezo-operated, electro-hydraulic servo-valves move the nozzle needle by push rods with high precision. According to this technology exact dosing and homogenous distribution will be obtained.

The application and further development of this injection technology is subject to utilizing this improved technology for further applications as mentioned before. Furthermore detailed design and configuring of nozzles, nozzle-needles, the arrangement of orifices in position and shape as well as arrangement of injectors are aspects of this invention.

b) Description and economical benefit of the present invention.

i) Introduction into the plastic melt stream. The introduction happens after the plasticizing unit. This is for many processes listed below having advantages noted. Producing material of different properties out of one Plasticizing unit is possible.

ii) For Injection moulding systems, predetermined properties like porosity, coloring are possible by one process step through variable introduction. Only multi-component injection moulding machines can accomplish this today.

iii) For extruder systems, profiles can be extruded with different components at predetermined sections which can be foamed by diverting the plastic melt stream and introducing gas creators in one side stream by an injector so that this melt stream will expand and joined together with the material of the main stream.

iv) Plastics for sheet and tube extruders can be introduced with dyes, gas processors and softeners after the extruder. Therefore a fast change of the material properties is possible that leads to economical flexibility in the production process.

v) Pelletizing systems in the nutrition can be modified by introducing flavors and additives after the extruder by injectors, so that the material does not have to go through all the total length of the screw.

vi) Chemical and process-technological systems like distillation-water-treatment plants and oil refineries can utilize the invention. In this regard, the introduction and dosing and the homogenous distribution of bleaching agents,

solvents in circuits of cellulose, pulp and mechanical wood pulp happens according to the state of art by dosing units with subsequent mixing. High shear forces are needed for the efficient mixing. Further, any modification of the operation parameters (because there is a change in the amount of additives or changing of color chemical additives) will have an effect only after completing a total running through of one plastisicing circuit.

The following application, processes and devices can be economically realized with the invention:

- Introducing, dosing and homogenous distribution of additives as there are hardener, dyes, gas processors, softener, reactant into the melt stream of plastics in:
  - Extrusion systems for sheets, tubes and profiles.
  - Compounding systems for production and adaptation of plastics.
  - Injection moulding, forming operation, preform manufacturing systems.
  - Auxiliary processing, forming operation, preform manufacturing systems.
- Introducing, dosing and homogenous distribution of catalyzers, reactants in flowing liquid in chemical, processing systems as well as, for instance, distillation water treatment, refinery systems.
- Introducing, dosing and homogenous distribution of blowing agents, solvents into the circuit of pulp and ground wood systems.
- Introducing, dosing and homogenous distribution into alloys and metallurgical additives as well as gas processors into the metal melt flow of die casting, profile casting and continuous casting systems.
- Introducing, dosing and homogenous distribution of additives and flavor agents for palletizing, dough and noodle processing systems in the nutrition industry.
- Introducing, dosing and homogenous distribution of fuel into combustion systems.



- Introducing, dosing and homogenous distribution of dyes and solvents in airless and spraying systems.
- Introducing, dosing and homogenous distribution of additives into fluidized material like bulk and powder material, granules, pellets in plants operating fluidized bed and whirl sintering installations.

c) Method of introducing additives.

Exact dosing and homogenous distribution is utilized. The present invention relates to introducing additives for instance gas processors into the melt stream of plastics or low melting metals.

The advantage of this process is the application of light weight structures at locations of a part where it is demanded. The gas processing substance for expanding the matrix material is introduced in spatially predetermined positions. Various operation modes and combination of these can be obtained firstly by pressure differences between melt and gas processing substances and secondly by the frequency of pulsation and thirdly by the shape of the nozzle reaching into the melt channel.

i) Creation of foam:

Creation of foam is possible using high frequency pulsation and therefore atomizing at high pressure differences and the advantages of counterflow and the subsequent high acceleration of the melt past variable sections of the melt channel. The difference in the speed of melt and additive is selected to be of a high value.

ii) Macro-hollow cavities:

The introduction happens by drop shaped dosing of the melt flow at low frequency of the pulsation and only small pressure difference in flow direction and essentially laminar streaming conditions of gas processors and melt.

iii) Continuous introduction:

Continuous introduction of a string of gas processors at nearly adequate flow speed of the passing medium. Small pressure difference is an advantage.

An apparatus for injection molding of compound parts with charger, which are connected to a pump which is compressing a chemical blowing agent has been published in DE1948454 by BAYER 1971 to achieve a spatially predetermined foaming. Because of the insufficient mixing and dosing the proposed foam quality cannot be reached. The present invention is demarcating from this apparatus by using injectors (combination of valve and nozzle) and pulsing injection and optionally using a continuously pressurized pipeline "common rail" and hydro-electrical activated valves. Because of the shaping of nozzles and channels according to hydrodynamic principles as well as regulated pressure, the apparatus is different. The solenoid is activated by electrical supply and optionally controlled to generate selected wave forms from an arbitrary wave generator. This leads to operation mode like atomizing, dosage and continuous string. The selection of pressure difference and frequency of pulsation leads to a predetermined introduction of gas processors into the melt. The exact dosing and pressure regulation leads to a targeted dosage of drops into the melt resulting in a subsequent macro hollow cavity expansion.

The apparatus for introduction of gas creating substances into the highly pressurized melt consists of a nozzle in immediate connection with a servo-valve, or consists of a pump-nozzle system with a non-return-valve combination.

The injection technology of combustion engineering has reached a high state of art concerning the exact repeatability due to the demands of strict exhaust specifications and is especially applicable to the invention. The state of the art is shown by "fuel-injection valves for internal combustion engines" disclosed in DE2028442, 1970, by DAIMLER BENZ. The hydraulic activation of the valve push rod is regulated by a three way valve. An "injection device" with hydro-electric activation was invented by PEUQUEOT, FR2145081, in 1971. The valve is pushed by a continuous hydraulic pressure and released by a controlled pressure loss on the backside of the push rod. In US3990422, 1973, by BENDIX CORP, the control of the hydro-electric activation has been improved by using a two circuit hydraulic system.

The present injectors show features which are necessary to comply with the demands of the inventive application and specification thereof. These are pressure regulation, electro-hydraulic activation by a push rod valve and pressure controlled by a sphere valve at the high pressure circuit, which is  
5 necessary to reach the high frequency pulsation and have the high pressure available at the nozzle needle immediately at the valve seat by a common rail system. This makes the accuracy independent of pressure and velocity differences between the gas creating substances and the melt.

The present invention relates to this high pressure technology which is to  
10 be adapted for the special condition of the introduction into the melt. The high pressure for injectors in combustion engines is needed for atomizing and distribution of the fuel in the combustion zone. The high pressure for injectors in melt introduction processes is needed to overcome the high melt pressure of about 100 to 140 MPa. Pressure of about 200 MPa can be reached by the  
15 available injectors with common rail. The continuous supply and the activation of the valves are solved with high reliability today.

An essential presupposition for running the injectors is the lubrication by the fuel because gas creating substances (water, alcohol, liquid gas) do not have substantial lubrication effect. The basic idea of the present invention is the  
20 use of two circuits applied to the standard injectors available in the market for making additional measures.

The patent JP 8170569 by NIPPON SOKEN, 1994, is showing a version of injectors for diesel engines by using a high pressurized circuit for injection and a low pressurized circuit for the servo hydraulic system. The inventive injector  
25 operates by separation of the hydro-electrical activation of the push rod of the valve which uses standard hydraulic oil and the introduction of gas creating substances happens at a slightly lower pressure (different than JP 8170569) because of a non return lock pressure that prevents penetration of the melt into the injector. Only the needle and seat of the valve are in touch with the non  
30 lubrication medium. These parts can be made of sintered highly wear resistant

material and are easily changeable. The electro-hydraulic servo circuit is not effected because of the separate circuit.

Further alternative solution for the injector are:

- 1) Pump nozzle system with a combination of high pressure piston  
5 and spherical valves.
- 2) An electric activated swing system attached to a pump piston.
- 3) Limits for the stroke and positioning of the inlet valve as known for  
airless spraying systems can be used as well. In some applications, it is an  
advantage to have a small pressure difference between the introduced material  
10 and the melt. For this the above solution can be used.

The regulation and control of the introduction process has the following  
features. Optionally, the hydraulic circuit can be separated from the gas  
creating substances to be introduced. The pressure  $p_1$  of the medium to be  
introduced and the pressure  $p_2$  of the hydraulic system are regulated by a  
15 pressure limit valve. The controller regulating the pressure depends on the melt  
 $p_3$ , for the hydraulic system circuit as well as the injection pressure of the  
introduced medium. The injector is activated by a solenoid or piezo actuator.  
The regulation is controlled by an "Arbitrary Wave Form Generator", known to  
those skilled in the art. Furthermore, the specification of hydraulic, nozzles,  
20 injectors and melt channel are described below.

The hydraulics for continuous production for instance extrusion,  
continuous casting and for part production by injection moulding and die casting  
are prescribed. The system for continuous production is used for extruders.  
Continuous charging and multiple injector assembly is preferred. The system for  
25 part production is used in injection moulding and die casting systems. Because  
of the interruption after the injection a simple solution using a pressure multiplier  
double cylinder is offered for injection moulding systems. The hydraulic system  
of existing machines have usually a pressure of 26 MPa that can be used to  
produce high pressure by a pressure multiplying system. While plastification  
30 takes place, the pressure multiplier for the hydraulic system as well as for the

introducing system is loaded with hydraulic oil and gas creating substance respectively. For the dosage of the melt with concrete size and spatially predetermined position it is necessary to achieve a constant pressure difference while injection takes place. A high pressure difference leads to the destroying of the melt. The ramping of the pressure is shown in figure 9. The injection pressure increases to the nominal pressure during the injection operation. During the injection the gas creating medium must be introduced by a higher pressure than the melt. The velocity of the melt in the gate of the mould has to be equivalent to the introduction speed of the gas creating medium. For achieving this feature an exact pressure regulation with electrical pressure limit and a precise activation of the hydro-electric valves is necessary. The shaping of the valve, valve seat and the smooth configuration of the melt channel according to hydrodynamic principles is important for repeatable dosage of the melt. The injectors of the "common rail technology" have the capability to fulfill these features.

The regulation of the solenoid takes place by controlling with "Arbitrary Wave Form Generator", opening and locking can be optimized by this system. Furthermore the shape of nozzle and melt channel is described.

d) Examples of introducing additives.

The present process relates to the modification of the properties (compounding) of an origin extruded material by diversion of the main stream into a side stream and introducing additives into this side stream by dosing, mixing and distribution of the original material. The kind of additives determine the properties of the plastic material of the melt. These additives are for instance additional components such as hardeners, dyes, gas processors, softeners, fillers and reinforcements.

This process can be applied to inside melt channels of mould for extrusion as well as for injection moulding systems, by means of using at least two diverted streams of melt to reach different properties of the plastic material.

Profiles produced by this process have different properties of the material at spatially predetermined positions. This method saves an additional extruder to produce the additional material component. The essential advantage is, that based on the same origin material the waste disposal is not necessary, because based on the same material the recycling results in a unique material. The additives are introduced by nozzle, injector, charging tube, mixing head, porous sinter metal, sliding pump, charger and spraying system. The following concrete application for production of profiles are subsequently shown for instance:

i) PVC Window profiles.

Sections of the profile close to the outside or inside can be insulated with the present process by using foam filling at the concerned chambers. The calipers as used for the known multiple chamber systems will be adapted with inside channels and with the present described devices. From the main melt stream, diverted material comes to the channel duct within the caliber in which by means of a metering regulation (as there are valve, throttle) the melt is fed to the device for introduction of the additives. Subsequently devices for mixing and homogenizing are placed in the channel to complete the compounding process. Using PVC for the window profile the additive will be physical gas creators like water, carbon dioxide, alcohol, glycerin, etc. The pressure ramping in the melt duct is decreasing because the additives provide additional gas volume. For expansion of the material a conical zone is configured according to the volume increase or the velocity increase and the additional volume comes to an expansion zone (conical increasing outlet) so that the compounded material is fed to the outside solid PVC profile shells and can be homogenous and adhesively bound together. The advantage of the profiles with multi components comes by the cost effective production and the better properties of the material for heat and sound insulation (low pressure within the foam cells and therefore lower heat transfer rates) and less cost for recycling of the waste material. As a variation, the additives can be introduced by singular dosage leading to a profile

with honeycomb shaped cellular structures of high strength. These structures replace the necessary stiffener profiles.

ii) Window profiles out of Polyolefins.

This is as described above but using Polypropylene PP or Polyethylene PE, HDPE, etc.

iii) Claddings or panel shaped coverings for outside or inside walls.

This is simpler than described above. The total extruded profile with foam core and large cell structure can be obtained by one diverted material stream from the main stream to be compounded within the center of the profile. The subsequent process of calibrating and cooling remains the same as before. The so obtained profiles can be used for inside cladding, mobile walls etc. having high stiffness by using large cell striker.

iv) Tubes from PVC, PO

Because of suitable introduction of gas creating and/or fillers, or reinforcement to the melt stream into spatially predetermined locations (as there are intermediate layer, outside layers, etc.), a multi component tube can be produced with simple measures. The device for compounding is attached in between the flanges of extruder and mould and is supplied by the channels of the mould to modify the properties of the material. Another production process with excellent mixing of the melt consists of introducing the additives before the cellular pump. Another improvement can be installed by attaching a mixer or dynamic mixing head for homogenous compounding.

v) Coloring of the outside layers of the profiles.

The introduction of dyes into the diverted melt channel makes it possible to produce a fast changeable coloring process. The process is most economical, because the expensive dyes are only applied on the outside and no loss of material happens by changing of color because the extruder does not have to be emptied completely. The change of the color comes into force immediately. Further possibilities for cost reduction can be achieved by bringing the coloring to the outside layers only.

vi) Production of sheets, insulation sheet material and compound sheets.

5 For systems having a large working width, the additives can be introduced into the center layer of the extruded sheet, or diverted to a melt channel similar to that described before for the device as implemented into the calipers having the total width of the sheet.

vii) Apparatus for adding up a extrusion system for multi component process.

10 The apparatus will be attached in between the flanges of the extruder and the mould. Following elements are included:

- 1) Inlet cones with diverting device for the melt channels;
- 2) Pressure and volume metering system;
- 15 3) Device for introduction of the additives optional consisting of nozzle, injector, charging pipe, mixing head, porous sinter metal, sliding pump, charger or spraying system (The mixer consist of static mixer, for instance with shafts, pins, diaphragms, helical zones.), and,
- 20 4) The expansion zone consists of variable sections, especially for foam components or macro cellular structures in the melt stream.

viii) Apparatus for dosage and mixing of additives into liquid medium by using valve cone orifice or pocket hole orifice, especially hot runner valve.

25 The invention relates to a multifunctional mixing and dosing head, consisting of a nozzle cone and a nozzle needle, in which the volume flow is metered or blocking the outside flowing medium by the position of the outside nozzle needle and consisting of a nozzle cone and a nozzle needle, in which the volume flow is metered or blocking the inside flowing medium by the position of the inside nozzle needle.

30 This combination of valve, nozzle and injector leads to an economical mixing and dosing directly on the needle top of the concentric double cone. The invention also relates to a hot runner valve, having an injector, for introducing the additives into the outer flowing medium, instead of the valve needle. Several



combinations of mixing and dosing heads are mentioned, especially the attachment to plasticizing unit, extruders, melt channel and the subsequent attachment of static mixer systems.

5 The economical benefit consists of the spatially predetermined location of the dosage and the excellent mixing and the exact dosing according to the mixing ratio. Applications for this hot runner valve with integrated mixing head includes introducing additives like dyes, hardener, softener, gas processors, etc. directly into the plastic melt and immediately before the gate of the mould. Besides the several known two component hot runner valves, the present  
10 suggested solution has the following features:

The application of the concentric positioned nozzle needles within the nozzle needle of this invention can be compared to EP 0310 914, 1987, "Process for Injection Moulding" (BATTENFELD), where a concentric positioned nozzle needle is shown in figure G.1 to 6.5. The present apparatus is  
15 demarcating from the above by using a spatially predetermined dosing of the melt while in EP 0310914 only each of the two media is switched to the mould. The present apparatus can achieve any mixing ratio in between by using the introduction of the additives by pulsation.

In US 4657496, 1987, by HUSKY, a hot runner valve for 2 components is  
20 presented with concentric positioned charging tube. By the cavities (9) and (6) within the nozzle needle, depending on the position either the one or the other component is blocked or opened respectively. The concentric shaping of the inside located nozzle makes it possible to regulate the dosing by moving the outside nozzle needle. which is controlled by the inner or outer nozzle. A mixing  
25 or a fast pulsing introduction as shown by the present apparatus is not a subject of the US 4,657,496 Patents.

The target of the present invention is not only to introduce at least two media in a concentric manner, but also to achieve a mixing, i.e., to dosage the outer medium with the inner medium.

In US 5,286,184, a variation of the concentric nozzle is published, which differs from US 4,657,496, in that it discloses the activation of the hollow shaped nozzle needle. Also in this case, there is a concentric introduction, but no mixing or dosage is the target.

5           The nozzle needle is activated by a push rod within the boring of the nozzle needle and is regulated by a servo-mechanic. To reach a spatially predetermined position by the dosage and/or dosing and excellent mixing the usage of a valve cone orifice VCO and a CDI injectors, as it is used in combustion engines, is an advantage. The activation of the injector is known by  
10       a hydraulic piston but also can use for the servo-mechanics for instance, solenoid, piezo actuator, hydraulic servo, etc.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

15           The invention may take form in certain parts and arrangement of parts, preferred embodiments of which will be described in detail and illustrated in the accompanying drawings which form a part hereof and wherein:

          Figure 1 is a schematic sectioned view of a valve cone orifice nozzle tip;

          Figure 2 is a sectioned view similar to Figure 1 illustrating a pocket hole  
20       orifice;

          Figure 3 is an elevation schematic view of a dosing and mixing arrangement;

          Figure 4 is a top view of the schematic arrangement illustrated in Figure  
3;

25           Figure 5 is a schematic, cross-sectioned view of a tube shown in Figure 3;

          Figure 6 is a schematically sectioned plan view of an extruder mold reducing the cylindrical profile;

          Figure 7 is an enlarged, schematically sectioned view of one of the nozzles illustrated in Figure 6;

30           Figure 8 is a schematic, sectioned plan view of an injector fitted to a tube;

Figure 9 is an enlarged view of the injection nozzle/tube arrangement illustrated in Figure 8 showing cascade distribution of the injection;

Figures 10 and 11 are schematically sectioned elevation views showing the invention applied with a plasticating screw;

5        Figure 12 is a schematic elevation view showing the invention applied after the mold gate of a plasticating screw arrangement;

Figures 13 and 14 are schematic representations indicating the nozzle flow pattern;

10        Figure 15 is a schematic representation of a dosing and mixing arrangement for a combustion system;

Figure 16a is a schematic representation of a mold for an extruder;

Figure 16b is an orthogonal representation of the mold depicted in Figure 16a;

15        Figures 17a and 17b are views similar to Figures 16a and 16b respectively;

Figure 18 is a schematic operating diagram for standard injectors used in the present invention;

Figure 19 is a schematic, cross-sectional elevation view of a standard, conventional injector shown with a pocket hole valve;

20        Figure 20 is a schematic elevation view of a prior art injector;

Figures 21 and 22 are views similar to Figure 20 showing modifications to the injector;

Figure 23 is a schematic elevation view showing a pump nozzle configuration;

25        Figure 24 is a view similar to Figure 23 illustrating an airless spraying system;

Figure 25 is a hydraulic circuit representation for the application of the invention's injection molding and die casting system;

Figure 26 is a graph showing melt pressure traces as a function of time;

Figures 27, 28 and 29 are schematic representations of various melt channels used with the invention;

Figure 30 is a depiction of several different nozzles designated "a", "b", "c", capable of being used with the invention;

5        Figures 31, 32 and 33 are also depictions of nozzle configurations with orifice views designated by "b";

Figure 34 is a schematic elevation view depicting the device compounding a melt stream;

10        Figure 35 is a schematic representation of a plan view of the arrangement shown in Figure 34;

Figures 36a and 36b are cross-sectioned views of the outlet and inlet, respectively, of the arrangement shown in Figures 34 and 35 illustrating the condition of the melt therein;

15        Figures 37a and 37b are schematic view of the outlet and inlet, respectively, of the nozzle disclosed in Figure 33;

Figure 38 is a schematic elevation view of a melt chamber;

Figure 39 is a schematic elevation view of a melt chamber similar to Figure 38;

20        Figures 40a, 40b, 40c and 40d illustrate various profile shapes capable of being produced by the subject invention;

Figure 41 is a schematic elevation view of the melt channel similar to that shown, for example, in Figures 38 and 39;

Figure 42 is an enlarged view of the injector used in the melt channel shown in Figure 41;

25        Figure 43 is an elevation view of a hot runner valve;

Figure 44 is a view of the orifice of the hot runner valve shown in Figure 43 in greater detail with the nozzle/orifice arrangement of the present invention depicted on the right side of the drawing and prior art injector nozzle arrangement shown on the left side of the drawing;

Figures 45a, 45b and 45c schematically depict, respectively, progressively closing positions of the needle valve used in the subject invention;

Figures 46a, 46b and 46c represent enlarged views of the orifice/needle shown in Figures 45a, 45b and 45c, respectively;

5        Figures 47 and 48 are schematic elevation representations of an injector in the hot runner valve; and,

Figures 49 and 50 are elevation schematic cross-sectioned views of the injector applied to specific melt channels.

## 10                                    **DETAILED DESCRIPTION OF THE INVENTION**

Referring now to the drawings wherein the showings are for the purpose of illustrating preferred embodiments of the invention and not for the purpose of limiting the same, there is shown in Figures 1 and 2 nozzles, nozzle needles and  
15        nozzle seats. The subsequent Figures 3 through 17 show samples for the application of the present method of introduction with exact dosing and homogenous distribution. In figure 1 and 2 nozzles and nozzle needles and needle seats are shown. The subsequent figures 3 to 17 show samples for the application of the present method of introduction with exact dosing and  
20        homogenous distribution.

Figure 1 shows a valve cone orifice, "VCO" nozzle tip. With (1) the nozzle needle closing the needle seat (3) is located in the nozzle body (2). The small volume of the front chamber (5) is the target of the VCO. The orifices (4) are inclined about 80° to the axis as used in combustion engines. Other orifices  
25        (6) shown on the right side of the axis having a stepwise inclinations of 0° to 75° inclined to the axis.

In figure 2, a pocket hole orifice is shown. The larger front chamber (8) of the nozzle gives a larger volume of free drops, by means an inexact dosing. The larger chamber gives the possibility of several radial arranged orifices (6) as well  
30        as an axial positioned orifice (7).

In figure 3, an arrangement of a dosing and mixing arrangement for a flowing medium in a tube (10) is drawn with five injectors (11) reaching into the tube. The injectors are connected to a high pressure pipeline (12) containing the additive. The tank (14), the high pressure pump (9) and the common rail (15) and the leakage pipe (13) are shown.

In figure 4, an arrangement of figure 3 is shown from the top view for a extrusion system. The dosing and mixing unit is positioned in flow direction between the cellular pump (16) the mixing tube (10) and mixer (10) and the mould (22)

Figure 5 shows a sectional view of the tube (10) which is enlarged. The five nozzle tips (2) are in a radial 72° pattern arranged. Each nozzle tip has 7 orifices positioned in an angle of 75°, 50°, 25° and 0°, etc. The jet of the injection (18) gives a complete covering of the section of the medium (17). The length of the jet stream is determined by the diameter of the orifice and is usual between 0.11mm and 0.14mm.

Figure 6 shows a mould for an extruder producing a cylindrical profile. Two of the several arranged injectors (11) are shown in the section. The additives (18) are introduced according to the velocity of the medium (17) in the flow direction.

In figure 7 the detail of the nozzle arrangement is drawn. The nozzle bodies (2) have at least one orifice (4) in the direction of the melt channel. The jet stream is directed to bring the additives, not wall sides (10), into the core (38) of the stream.

In figure 8 an application for a single injector is arranged which is inclined about 45° to the tube axis (10). The orifice (4) is inclined in a flat slope angle to the medium flow i.e. the orifice is positioned about 40° out of the axis of the injector. The pulsing introduction is giving a cascade distribution shown in figure 9.

Figure 10 gives applications for injection moulding systems. Similar to figures 8 and 9, two injectors (11) are introducing the with a light slope in

direction of the axis of the nozzle tip (21) of the plastisicing unit. The location of the injector is after the screw tip (40) but within the front chamber (20) of the barrel (19). Further excellent mixing, for example of dyes can be had. This arrangement also can be placed within screw sectors within the plastisicing arrangement.

For accurate dosing with less mixing the arrangement of figure 11 takes place. The introduction happens in the center hole of the plastisicing nozzle tip (21). This is used for application with hardener and softener (minimum leakage).

In figure 12 the introduction happens by the injector (11) immediately after the mould gate at the inlet of the mould (22). The advantage of a hot runner system (23) is evident. The Mixture of medium and additives is not depending on the plastisicing unit (19) but determined by the introduction of additives, i.e., flexible and variable.

Figure 13 shows an airless jet stream (25). The flowing medium (39) is the streaming side air. The additive is dyes (18). The pulsation determines the coloring conditions.

The nozzle arrangement is shown in figure 14. At least one orifice (4) in the nozzle body (2) is directed near the axis and determines the spraying structure (18).

In figure 15 the dosing and mixing arrangement is shown for a combustion system. The nozzle body (2) is reaching into the combustion chamber (27) and is limited by the casing (28) of the burner zone. The combustion air is compressed by a blower (26) and the atomizing of the fuel uses the standard arrangement of orifices located on a cone. The injection jet stream (18) results in accurate dosing and mixing of the perfect combustion. (29)

In figures 16a and 16b the application of a mould for an extruder production of profiles - for instance window profiles - is arranged. The dosing and mixing have the purpose of modifying material diverted from the main stream of the melt for example with gas processors. The section shape is shown in figure 16 b. The injector (11) reaches into the side channel (30). The

different material streams (31) are separated by inlet channels, calipers (32). The melt stream (17) is introduced (18) by additives and is creating foam in the side stream which is transported to the chambers (33) and (34). Chambers with solid calipers creating hollow profile space is usual.

5           In figures 17a and b the introduction of additives (18) by pulsation into the side channel is shown. The arrangement is also for extrusion systems as in figure 16 as well as for pelletizing and continuous casting with mixing zone (10) applicable. Figure 17a shows the tube section (30) and the single tube (10). Figure 17b shows the lateral section of the tube (30/10). The nozzle body (2) is  
10   having 7 radial arranged orifices (4) and giving full coverage of the material section (17) by the jet streams (18) for dosing and mixing. A sequence of several jet streams (36) respectively (37) introduced in flow direction are shown in 17b.

          In figure 18 the total apparatus for injectors of standard design is given in  
15   the layout. The utilization of pumps (101) and (105) enable the application to be used in a continuous operation (extrusion). The circuit for the additives (103) is separated from the circuit of the hydraulic oil of the servo (104). The pressure of the circuits is regulated by an electrically activated presser limit valve (102, 106). The valve (112) is released by electro-hydraulic mechanics. The mechanics  
20   consists of a solenoid (109) a spherical valve (108) and the push rod connected to the high pressure piston (110). The controller (122) is regulating the electro-hydraulic mechanics according to the information (120) given by the operation data as there is injection time/extrusion data (123) according to the pressure sensor in the melt (115) of the pressure of the additive circuit (102) and the  
25   pressure of the hydraulic oil of the servo (106).

          The arbitrary wave form generator (120) creates the opening current for the electro mechanism (112). The introduction of the gas processors (117) into the melt stream (114) happens in the interface (116) part after the extruder tip (160) by a nozzle (113) reaching into the channel. For heating, a heater band  
30   (159) is located around the nozzle (113).



Figure 19 shows a standard injector. This version shows a pocket hole valve (113) with a small front chamber. The valve seat (112) is locking the nozzle from the continuous pressurized circuit.

5 The push spring (131) increases the force resulting from the difference of force on the nozzle needle (112) and the hydraulic pressing (110). The opening is activated by the solenoid (109) which releases the sphere of the valve (108) and hydraulic oil of the servo is streaming out of the high pressure chamber (110).

10 Figure 20 shows an injector of the state of art. The essential features can be readily recognized. The version with the electro-hydraulic activation is extended by throttle (129) and anchor(127) and double chamber. Standard Injectors having separate inlets (126) for the servo supply and the injection supply.

15 Figure 21 shows a section of a modification of a standard "common rail injector". The already available two supply borings are attached to a special fitting.

20 Figure 22 shows the modification of a standard "common rail injector" with a second boring. The supply (132) of the hydraulic servo circuit is blocked by a pin. Additional supply is given by a boring (133) and a second fitting (126) for the servo circuit.

25 Figure 23 shows a pump-nozzle configuration in principle, by means of the high pressure chamber being close to the location of the nozzle. The medium of the additive is supplied through a boring in the push rod (135) and the pressurizing is effected by an inlet valve (137) and an outlet-valve (139). The penetration of the melt into the injector is prevented by a sphere (137) which is pressed by a non-return-spring (138) into the valve seat. The push rod (135) is activated by a magnetic swing system (127). By stroke limit (134) the size of the pulsation is determined. The line for leakage (140) returns the overflowing medium.

Figure 24 shows the principle of an airless spraying state of the art system, applied to the present application by using a valve sphere (139) within the nozzle. The advantage of a small front chamber can be reached by a overlapping (141) of the sphere valve (134,135,140) as shown in figure 23.

5           Figure 25 shows a hydraulic system for part production for instance for injection moulding and die casting systems. The operation of the injector is having a twin circuit system. The pressure multiplier is connected to the basic hydraulic system of the machine (142). While processing the part there is time to load the system for injection. The pressure multiplier cylinder for the additive  
10       (143) and for the servo hydraulic oil (144) are pressurized and being regulated by the pressure limit valve (142) during the melt injection having the pressure  $p_4$ . Subsequently the chambers of the cylinders are refilled by pumps (101) for the additive and pumps (105) for the hydraulic oil.

          Figure 26 showing the features of the pressure ramping y-axis in MPa  
15       (145) over the duration for the present processing. The melt pressure  $p_3$  is shown by the curve (148). The pressure of the additive  $p_1$  is shown by curve (146), the pressure of the servo hydraulic  $p_2$  shown with the line (147). The electric potential (153) to activate the electro-hydraulic regulation is shown by the curve (149). Various wave forms can be produced and are shown by way of  
20       example as triangle (154), half sinus waves (155) at different frequencies and full sinus wave form (156) with different frequencies and phases or full sinus form (157) in different frequency or different phases (158) as well as unsymmetrical wave forms, all being produced by an arbitrary wave form generator.

25           Figures 27, 28 and 29 show several melt channels. Figure 27 shows a parallel melt channel (114) in flow direction positioned orifice having an interface part (116) between mould (162) and nozzle tip (160) of the barrel. This arrangement is applicable for dosage with drops (161) into the melt stream (114). Figure 28 shows a radial multiple orifice (163) in flow and counterflow  
30       position for excellent mixing of the additives with the melt in an enlarged melt

channel (114) which causes additional mixing by change of velocity. Figure 29 shows a continuous string introduction (164) into the melt channel. These method is able to process axial hollow cavities for extruded profiles.

Figures 30,31 and 32 show a nozzle with various orifices. Figure 30  
5 shows state of the art. 30a shows a VCO valve cone orifice. Figure 30b shows radial multiple orifices. Figure 30c shows pocket hole orifices. Figure 31 shows a nozzle for flow and counterflow introduction. For introduction of additives as drops into the melt the nozzle is designed according to hydrodynamic principles. For preventing atomizing, sharp edges have to be avoided. The channel profile  
10 has smooth profiles in valve cone (170) and at the nozzle profiles (171). Figure 32 shows a nozzle introducing drops sidewise in flow direction. Figure 33 shows a nozzle for atomizing in the conical seat (172) and plane seat (173) rectangular to the flow direction.

Figure 34 shows a detail of the device for compounding a melt stream.  
15 This version is implemented in calipers (53) of profile moulds (51) or for array assembly for moulds to produce sheets. The section is showing details of figures 16a and 16b. The view shows the material flow from right to left. The caliber (53) at the inlet side is conical (64) shaped. The inlet is having a pressure sensor (63) connected to the controller (62) and supplying data to it.  
20 The introduction is flow direction (55b) and counterflow (55a). The advantage of the counterflow is the introduction of individually closed dosages. The introduction may optionally be caused by pulsation. For instance chicanes for the melt. The change of velocity leads to shear forces and to additional mixing respectively in the expansion zone (60).

25 Figure 35 shows the top view of figure 34 and the relevant numbers are the same. Note the narrow section in the melt channel.

In figures 36a and 36b the section of the inlet and outlet is shown related to the device in figures 34 and 35. Figure 36b shows the inlet in a sectional view.

Figures 37a and 37b show the version of the invention as it is in figures 33a and 33b but for simple foamed profiles as there are claddings with integrated insulation, panels and tubes. Reference numbers are the same as in figure 33.

5           Figure 38 shows a version of melt channel before the distribution chamber of the mould. Two inlet cones (64), (65) and the center inlets (66) provide a twin chamber to the melt.

          Figure 39 shows a version of melt channel design with central inlet of the side channel and a concentrically (twin) introduction of additives and subsequent  
10           merging of the melt at spatially predetermined locations of the profile. The melt channel is crossing the main channel (67) in the center of the surrounded flow.

          Figure 40a shows a rectangular profile. Figure 40b shows a circle, tube profile. Figure 40c shows an elliptical profile and figure 40d shows a rounded rectangular profile. Several profile shapes with multiple components are shown  
15           for instance in figures 33, 38, 39 and 41 as being produced as simple tubular profiles.

          Figure 41 sketches a device with an add up for existing extrusion systems and can be modified for multi-component operation. For reference, (68) is the flange of the melt channel (69) and is the flange of the extruder, while (70) is the  
20           interface part for adding up and (71) is the melt channel with through put.

          Figure 42 shows the device in Fig. 41 in detail. The device is made out of a disc (70) and attached between flanges (68) and (69). The disc has injectors for introduction of the additives as well as diaphragms (72) to divert the melt channel. The tube (72) with attached planes for the hollow calipers is shown in  
25           principle.

          In figures 43 to 46, hot runner valves for injection moulding systems are shown.

          In figure 44, a device in accordance with the invention is compared to a the state of art device.

Figures 45A to 45C show the progressive activation of the needle tip and figures 46A to 46C correspond to figures 45A to 45C, respectively, and show the needle tip in detail.

Figure 47 shows the version of the invention with high frequency pulsing  
5 (CDI Injector).

Figure 48 shows the integration of CDI Injectors in the hot runner valve.

Figure 49 shows the arrangement of a mixing and dosing head for example in the melt channel of the plasticizing unit of an injection moulding machine or an extruder.

10 Figure 50 shows an arrangement of a twin unit in counterflow used for liquid/liquid mixing as well as for extruders with a subsequent static mixer.

Figure 43 shows a device for mixing and dosing and dosage. The inner nozzle needle (82) is activated by the adjusting device (93) and is in the shape of the seat (83) for a pocket hole orifice or a valve cone orifice. This insert also  
15 is part of the outer nozzle needle and shaped to be attached to the actuator piston (90). The supply of the additive happens by the boring (85) and is again attached to the interface (91). The viscous medium is supplied by the channel (89) and passes between the outer nozzle (81) and the supply tube (94,) for instance a hot runner valve a plasticizing unit or a melt channel of an extruder to  
20 the final destination.

In Figure 44 the nozzle beneath "Prior Art" shows the version of a conventional inner nozzle needle as a push rod (84), as well as the inner nozzle seat, as well as the outer nozzle (94), or both according to the position of the push rod (84) for opening or locking. The outer nozzle needle is moved and  
25 regulated according to the supply of the outer medium. In Figure 44 the present device is shown and has a nozzle insert (83) as shown in the figure as a valve cone (VCO). The orifices of the inner nozzle (83) are completely covered when inside needle (82) is locked. The inner substance is supplied between the nozzle needle (82) and the valve cone orifice (83) and is introduced in the inlet  
30 to the outer medium (89). According to the position of the inner nozzle (82) and

the pulsation, the atomizing of the introduced substance (85) into the outer medium (89) occurs. The conical shaped outer nozzle needle (83), being at the same function for the inner nozzle needle is locking the orifices of the nozzle seat of the hot runner (94) of the plasticizing unit (95) or of the melt channel of an (97), and regulates the opening according to the demanded volume flow and the introduction of the two media (92).

In figure 45A the open position for introducing the outer medium is shown. The outer nozzle needle (81) is open. The inner nozzle (82) is closed. The substance (85) cannot penetrate. In figure 45B the inner nozzle needle (82) is open and gives space for the valve cone orifices (83) and the inner substance (85) is introducing to the outer medium (92). In figure 45C the inner nozzle needle (82), as well as the outer nozzle needle (83) is closed.

Figures 46A , 46B, 46C are corresponding to figures 45A, 45B, 45C but show enlarged details.

Figure 47 shows the combination of a CDI injector (88) in a nozzle seat as cone valve/pocket hole nozzle (87), having the function of the nozzle needle in the needle seat of the melt channel and closing the valve seat of the hot runner valve (94). The CDI injector is activated by the position device (93). The inner  
 5 nozzle needle is activated by a solenoid/hydraulic or a piezo/hydraulic servo. The supply of the substance happens through the fitting (91). The melt is supplied by the channel (89).

Figure 48 is showing details of figure 46 and differs by the melt channel (89) attached as a separate insert (87).

10 Figure 49 shows the arrangement of a mixing and dosing head (95) inside the nozzle tip of the plasticizing unit (96) of an injection moulding system. The insert (87) reaches into the mixing head (95) and the outer nozzle (81) and at the same time as the insert (87) regulates the flow of the melt (89).

Figure 50 shows the dosing and mixing head (98) in a tube, for instance  
 15 in a tube as liquid/liquid mixer of a melt channel of an extrusion system (99). The inserts (87a, 87b) reach into the conical nozzle seat of the mixer and modify the outer nozzle needle (81) according to the position of the volume flow of the melt (89). The supply happens by a charging device (97) directing the melt into the conical valve seat. The additional mixing occurs by arranging the mixing  
 20 heads in a counter flow to have counter impact on the media flow. Optionally, this arrangement can have four media which can be mixed together. Optionally, a static mixer can be attached subsequent to the mixing and dosing device.

Indexing of reference numbers:

25	1. Nozzle needle precisely moved 2. Nozzle body 3. Nozzle needle seat 4. Plane plurality of orifice arrangement 5. Cavity at valve cone orifice VCO 6. Radial plurality of orifice	88. Common rail injector (CDI injector) 89. Supply channel for melt stream 90. Activator piston by hydraulics 91. Supply of the additives 92. Introduction of additives to the melt 93. Servo-mechanics for instance
30		

	arrangement	electro/hydraulic,
	7. Axial boring in nozzle body	piezo/hydraulic
	8. Cavity at valve sack orifice	94. Hotrunner Nozzle seat
	9. High pressure pump	95. Injection Molding nozzle seat
5	10. Channel of streaming medium	96. Injection Molding plasticizing nozzle
	11. Injector	97. Extrusion nozzle seat
	12. High pressure piping	98. Supply device
	13. Leakage backflow piping	99. Melt channel for extruders
	14. Container of additives	100. Static mixer
10	15. Common rail (communication system)	101. Feeding device for gas creators
	16. Cellular pump	102. Pressure controller for gas C. p1
	17. Streaming medium	103. Circuit for gas creator substance
	18. Injection spray stream	104. Hydraulic circuit for activation
15	19. Plasticizing barrel	105. Feeding device for hydraulic circuit
	20. Dosing chamber of barrel of injection moulding machines	106. Pressure control for hydraulic c. p2
	21. Nozzle of plasticizing barrel	107. Tank for hydraulic oil
	22. Mould	108. Spheres for valve
20	23. Hot runner system	109. Solenoid or piezo activator device
	24. Non-return-valve	110. Hydraulic activation of the valve
	25. Airless spraying system	111. Back pressure, seal
	26. Compressor	112. Valve for the injector
	27. Combustion air piping	113. Nozzle of injector
25	28. Combustion chamber	114. Gate of the melt stream
	29. Combustion zone	115. Pressure sensor-cell in melt stream
	30. Inner rod (caliber) of extrusion mould	116. Adapting device between the runner
	31. Section of extruded profile	117. Introduction of additives to the melt
30	32. Inner rod (caliber) for hollow section	118. Heaterband of the adapting device
	33. Foamed inner section	119. Pressure control for additives p3
	34. Hollow section	120. Arbitrary Wave Form Generator
	35. Extruded profile	121. Pressure controller for
35	36. Cascade shaped injection	
	37. Radial plurality of orifice arrangement for extrusion	
	38. Core of the mould	
	39. Jet streaming combustion air	
40	40. Screw of plasticizing unit	
	41. Expansion zone in the extrusion mould, preferable situated in the inner rod of the mould	



5	<p>51. Mould for production of profiles by extrusion</p> <p>52. Melt stream, feeding of melt from extruder to the mould</p> <p>53. Caliber inside the melt stream section, implementation for the mould to conduct the melt stream, particular with an integrated melt channel.</p>	<p>additives</p> <p>122. Controller</p> <p>123. Interface to injection moulding machine, extruder, die-casting</p> <p>124. Pump-nozzle combination</p> <p>125. Leakage piping</p> <p>126. Supply piping for hydraulic</p> <p>127. Anchor for solenoid activation</p> <p>128. Injector</p>
10	<p>54. Injector, nozzle for introducing of additives into the separately arranged melt channel.</p>	<p>129. Throttle valve</p> <p>130. Valve push rod</p>
	<p>55. Introduction of additives</p>	<p>131. Spring for clamping</p>
15	<p>55a. Introduction in flow direction</p>	<p>132. Feeder piping for gas creator</p>
	<p>55b. Introduction in counter flow</p>	<p>133. Additional channel for 2<sup>nd</sup> medium</p>
	<p>56. Outlet section of separately arranged melt channel.</p>	<p>134. Stopping device f. stroke limitation</p>
20	<p>57. Caliber inner rod for forming a hollow section and hollow profile.</p>	<p>135. Pump push rod</p>
	<p>58. Melt channel with original shaped extruded profile and the corresponding section.</p>	<p>136. Feeding pipeline valve</p>
25	<p>59. High pressure pump for additives.</p>	<p>137. Feeding pipeline for sphere valve</p>
	<p>60. Zone of expansion for the introduced gas creating additives.</p>	<p>138. Reverse motion spring 18</p>
30	<p>61. Adjustable section for controlled outflow, chicane for mixing</p>	<p>139. Backpressure valve on melt end</p>
	<p>621. Adjustable section for controlled inflow.</p>	<p>140. Leakage pipeline</p>
35	<p>63. Pressure sensing cell for the separately arranged melt stream as indicator.</p>	<p>141. Shrinkage of sphere seat</p>
	<p>64. Caliber inner rod with melt channel and inlet opening.</p>	<p>142. Hydraulic system of basic machine</p>
	<p>65. Tubular inlet section for multiple shell arrangement for extrusion profiles.</p>	<p>143. Pressure multiplier piston additive</p>
40	<p>66. Central inlet opening for the inner shell of the extrusion profile.</p>	<p>144. Pressure multiplier piston hydraulics</p>
		<p>145. Axis for force in MPa</p>
		<p>146. P1 pressure of additive</p>
		<p>147. P2 pressure of hydraulic</p>
		<p>148. P3 pressure of melt</p>
		<p>149. P5 pressure on control piston</p>
		<p>150. Axis of time</p>
		<p>151. Current supply to solenoid</p>
		<p>152. Center line</p>
		<p>153. Trapezoid wave shape</p>
		<p>154. Triangle wave shape</p>
		<p>155. Half sinus wave</p>
		<p>156. Full sinus wave</p>

[illegible]

Having thus defined the invention, it is claimed:

1) Method for introducing additives for exact dosing and homogenous distribution into flowing or fluidised media, whereas at least one nozzle with a  
5 nozzle needle and said nozzle needle is variable activated with high precision by a device, and the amount of additives is dosed in relation to the volume stream of the medium and said nozzle having at least one orifice and the additive is sprayed into the passing medium through said orifice with high pressure and with pulsation, maintaining high kinetic and pulse energy, reaching a penetration  
10 into the medium and a homogenous mixture.

2) Method for introducing fluid additives into flowing or fluidised media according to claim 1 wherein the additives are introduced and distributed by pulsing injection and at least one operating parameter concerning the additive,  
15 of the method as there are temperature, pressure, duration of pulses, frequency of pulses and operating parameter concerning the medium as there are temperature, Pressure, mass flow are variable controlled.

3) Method for introducing, for instance injection, atomizing according to  
20 claim 1 and 2, of at least one additive in melted, pasties, liquid, dissolved, dispersed, emulated condition, or a combination of this conditions are injected into a medium stream consisting of gas, liquid, melt, paste, plastics, solution, dispersion, emulsion, fluidised bulk material or a combination of this media, wherein the hydro-mechanical blending is carried out by variable pulsing  
25 activated injector, and the exact dosing and homogenous mixing is variable controlled by subsequent operation parameters:

Additives:

temperature,

pressure,

30 duration of pulse,

frequency,

Medium:

temperature,

pressure,

5 velocity of stream.

4) Method according to claim 1 to 3, wherein additives for instance hardener, dyes, gas producers, softeners are introduced and exactly dosed into plastic melt, metal melt or fluidized material and homogenous mixed.

10

5) Method according to claim 4, wherein the additives in die casting systems, optionally are introduced by pulsation into the barrel between two section of the plasticizing cylinder, into the front part of the plasticizing cylinder, before the nozzle, into the melt channel after the non-return-valve, into the Hotrunner system, into a side channel of the melt channel, into side channels of mould sectors.

15

6) Method according to claim 4, wherein the additives in extrusion systems, optional are introduced by pulsation into the barrel between to sections of the extruder plasticizing cylinder, into the barrel front chamber, into the melt channel after the extruder nozzle, after a cellular melt pump, into melt channels of the moulds, before the melt distribution system, into the section before the outlet.

20

7) Method according to claim 4, wherein additives in plastic injection moulding systems are introduced by pulsation optionally are introduced by pulsation into the barrel between two section of the plasticizing cylinder, into the front part of the plasticizing cylinder, before the nozzle, into the melt channel after the non-return-valve, into the Hotrunner system, into a side channel of the melt channel, into side channels of mould sectors

25

30

8) Method according to claim 1 to 3, wherein additives in pelletizing systems are introduced by pulsation into the mass flow optional between two sections of the pellet extruder, into the front chamber of the extruder, before the nozzle, into the mass flow channel after the extruder, in parts of the channels of the mould.

5

9) Method according to claim 1 to 3, wherein fuel/color are introduced by pulsation in burner/airless spraying-systems are introduced by pulsation into the combustion air stream/spraying stream.

10) Apparatus for introducing of at least one additive in melted, pasties, plastics, fluid, fluid-gas, solved, dispersed, emulated condition, or in combination of said conditions, into a medium stream consisting of liquid, gas, melt, paste, plastics, solvents, dispersents, emulgents, granules, pulp, homogenous material and bulk or combination of this media, wherein at least one variable pulsing activated injector reaches into the medium stream and at least one of the following features are designed:

15

Injector: number of nozzles

Orifice in the nozzle

Number

20

Direction

Diameter

Variable streamline section (Laval)

Valve of the nozzle

Needle of the nozzle

25

Seat of the needle

Blind pocket valve,

Valve cone orifice,

stream-bending

Geometric shape of the needle seat

30

Creation of pressure

- Pump-nozzle (pulsing)  
 Constant pump common rail  
 Activation of the needle  
 Mechanical  
 Hydraulic  
 One medium (activation and additive is identical)  
 Mechanical valve  
 Electro-magnetically valve  
 Solenoid  
 Piezoelectric  
 Separate medium for hydraulic and additive  
 Electrical  
 Solenoid  
 Piezo electric  
 Streamline section  
 Sectional shape  
 Variable streamline section (Laval)  
 Application of mixing devices
- 11) Apparatus for introduction of additives according to claim 10 for instance hardener, dyes, gas producers, softener into plastic- metal melt, wherein at least one injection nozzle or injector having at least one orifice of 0.08 to 0.2 mm diameter, designed according to the requirement of depth of penetration of the jet into the melt, the direction of the orifices, seat of nozzle as blind pocket valve for homogenous pressure ramping and equal pressure supply to all orifices or as VCO (valve cone orifice) for having small leakage volume and energetic atomizing, because of the narrow slot between nozzle needle and nozzle seat, optional is the activation of the needle by electro hydraulic system as servo valve driven by solenoid, or by piezoelectric actuator, or pneumatic, hydraulic or by extern magnetic field driven nozzle needle, or by linear drive system.

12) Apparatus according to claim 10 and 11, for injection moulding systems, wherein the injectors are located after the screw (40), optional reaching; into the front plasticizing chamber (20), into the melt channel after the nozzle (21), into the hot runner system (23), or directly before inlet to the mould (22).

5

13) Apparatus according to claim 10 and 11 for extrusion systems, wherein the injectors are located after the extruder optional reaching; into the melt channel (10) after the cell blade pump (16), into the melt channel before the mould (22) or into the mould between outer (10) and inner (22) caliber.

10

14) Apparatus according to claim 10 and 11 die casting systems, wherein the injectors are located after the melt extruder, optional reaching into the melt channel after the dosing pump, or into the mould (22). Figure 8 and 9.

15

15) Apparatus according to claim 10 and 11 for burner systems, wherein at least one injector (11) having at least one orifice being located on a cone with an opening angle between  $20^{\circ}$  and  $80^{\circ}$  and is reaching the combustion air stream (27) for current streaming.

20

16) Apparatus according to claim 10 and 11 for airless systems, wherein the injectors (11) having at least one orifice (4) which is about in the direction of the axis, are reaching the current streaming (39).

25

17) Apparatus according to claim 10 and 11 for extruder systems forming profiles for instance for window profiles, wherein at least one injector (11) is reaching into a side channel (31) of the main melt stream (17), and said side channel is advantageously embedded in a core (32) of the mould, and this channel consists of a conical shaped expansion zone (41). Fig 16 a and b.

18) Apparatus according to claim 10 and 11 for pelletizing systems, wherein at least one injector (11) reaches into the medium stream (17) and the nozzle body (2) is having at least one orifice (4) and said orifice is positioned rectangular to the flow direction.

5

19) Device of an apparatus for introduction of additives into melt of plastics or metal according to claim 10 to 18, wherein the injection nozzle (113) is immediately connected to the servo-valve (112) is formed as an injector (128),  
10 and connected to, at least one pressure controlled connection (common rail) and said connections optionally are separately configured for the hydraulic servo-circuit (104) and for the additives to be introduced (105) and that the pressure (102) of the said circuits of additives (103) and/or of the servo-hydraulic (104) optionally are controlled by a dynamic presser-valve (102, 106) by a controller  
15 (122) in relation to the melt pressure (119) and the hydraulic servo circuit (104) of the injector (128) is optionally activated by solenoid or piezo-actuator (109) and the controller (121) is activating the said injector (128) optional by a arbitrary wave form generator (120) and the said nozzle (113) of the said injector (128) is optional formed for operation mode of atomizing, pulsing and continuous  
20 introduction in flow or counterflow direction and the section of the gate of the melt channel (114) is according to the operation mode formed in reducing, continuous or expanding shape and the injector is having a Heaterband (159).

20) Device of an apparatus for introduction of additives into melt of plastics or  
25 metal according to claim 10 to 18, wherein the system for introduction is consisting of: a pulsing pump connected to a speed controlled motor, and said pump is for instance a crankshaft-inline-, radial-piston- and rotating-valve-version connected to the injectors; or a pump-nozzle-system (124) having a activation by a push-rod and shut-off-valve for operation to the melt (139)  
30 immediately attached to the nozzle or activation by frequency controlled



solenoid, or as a high pressure pump of an airless spraying system, or as pump of steam spraying system and the said nozzle (113) of the said injector (128) is optional formed for operation mode of atomizing, pulsing and continuous introduction in flow or counterflow direction and the section of the gate of the melt channel (114) is according to the operation mode formed in reducing, continuous or expanding shape and the injector is having a Heaterband (159).

21) Device according to claim 19 for continuous operation (extruder, continuous casting systems) consisting of at least one injector (128) reaching into the melt stream (114) and pressure sensors for the melt (115), for the hydraulic circuit (106) and the medium circuit (102), wherein the hydraulic circuit and the medium circuit is attached to a high pressure pump (101, 105) with a controllable pressure limit valve and the controller for the said pressure limit valve of the media is maintaining a constant differential pressure between medium circuit and melt and hydraulic circuit and medium circuit. FIG.: 18

22) Device according to claim 19 for interrupted operation (injection moulding, die casting systems) consisting of at least one injector (128) reaching into the melt stream (114) and pressure sensors for the melt (115), for the hydraulic circuit (106) and the medium circuit (102), wherein for each circuit - the hydraulic circuit (104) and the medium circuit (105) - is connected to a pressure multiplying cylinder (143, 144) and said cylinder is connected to the said system hydraulic (142) and connected to a pressure controller and said multiplying cylinder is pressurized according to the injection cycle and the said medium circuit and hydraulic circuit are loaded by a separate charging pump (101, 105) while the cylinders of the system hydraulic is discharged and the pressure control for the differential pressure is maintained about constant for the medium circuit (p1-p3) and for the hydraulic circuit (p2-p1). FIG.: 25

23) Modification of a standard injector according to claim 19, having a combined supply of fuel for the hydraulic circuit and fuel for the medium circuit, wherein the fitting for the supply circuit of the said injector is replaced by a special fitting having a separate boring for hydraulic and medium supply. FIG.:

5 21

24) Modification of a standard injector *having two borings in the supply circuit*) according to claim 19, having a combined supply of fuel for the hydraulic circuit and fuel for the medium circuit, wherein one boring of the said injector is blocked by a pin and the other circuit is kept open while the blocked circuit is modified by having a second fitting with boring separately. FIG.: 22

10

25) Pump-nozzle-system according to claim 20, wherein the non-return valve of the medium (139) is formed as a spherical, conical or elliptical valve and the injection chamber is configured immediate to said non-return-valve and the spherical-conical valve of the supply channel (137) is having an locking spring (138) pressing the said spherical-conical valve into the valve seat located on the push rod (135) having a supply boring (132) which is connected to the medium circuit. FIG.: 23

15

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26) High pressure pump-nozzle-system for airless systems according to claim 20, wherein the non-return-valve of the medium (139) is formed as a spherical-, conical valve and the nozzle-chamber (113) is configured immediate to the said spherical-, conical valve. FIG.: 24

25

27) Method for controlling the device according to claim 19 and 20, wherein the pressure of the hydraulic circuit (106) and of the Medium circuit (102) is activated by a electrical activated pressure limit valve which is regulated by a controller, according to the results of the pressure sensors measuring the melt pressure p3 (115) regulating the pressure p2 of the hydraulic circuit (106) above

30

the pressure  $p_1$  of the medium circuit (102) and regulating the said pressure  $p_1$  of the medium circuit above the melt pressure  $p_3$  (115).

28) Method for controlling the device according to claim 19 and 20, wherein  
5 the signal for the activation (108,109,110) of the electro-hydraulic servo-valve (112) of the injector (128) is given by a arbitrary wave form generator (120).

29) Injection nozzle and injection valve according to claim 19 and 20, wherein  
10 the interface part (116) is formed for swiveling around the injector axis and optional adjustable for flow- and counter flow-direction injection and the shape of the nozzle is formed according to hydrodynamic laminar flow conditions. FIG.: 31 and 32

30) Injection nozzle and injection valve according to claim 19 and 20, wherein  
15 the nozzle seat is having sharp edges (172, 173) and radial multiple orifices (167) to obtain atomizing. FIG.: 30 and 33

31) Melt channel according to claim 19 and 20, wherein the melt channel is  
20 having variable channel sections to obtain hydraulic speed changes. FIG.: 28 and 29

32) Method of manufacturing extruded profiles of different plastic components  
in systems consisting of extruder(s), mould and calibrating- and cooling line,  
wherein the melt stream of at least one extruder in the mould having at least two  
25 melt channels is processed by introducing additives for instance hardener, dyes, gas processors, softener, filler, reinforcement, etc., into the melt stream by an injector, charging pipe, nozzle, mixing head, porous sinter metal, pump-nozzle, charging device or spraying unit regulating the pressure of the additives according to the pressure of the melt stream and advantageously introduced by  
30 pulsation and optional the volume stream of the melt stream is regulated by a

throttle valve located at the inlet and mixing of the melt stream after the introduction of the additives by devices for instance pins, mixing shafts and labyrinth and applying shear forces according to the acceleration of the melt by variable channel sections consequently mixing the components having different properties, specific weight to the original material by configuring the melt channel in the mould having variable sections of the channel as there are expansion zones and having junctions inside the mould to unify the melt streams to one stream and subsequently creating a profile consisting of different material components melted together in the mould and passing the following calibrating and cooling section.

33) Apparatus for processing a separately diverged melt stream of an extruded mainstream according to claim 32 by means of distributor, statical mixer, caliber, mandrill, wherein the devices in the melt channel are configured of at least two features, as there are:

inlet with converging section,

pressure sensor reaching the inlet channel, connected to a controller

device for variable adjustable section as there are throttle valve, valve, sliding valve;

injector, charging pipe, nozzle, mixing head, porous sinter metal, sliding pump, charger, atomizer reaching into the melt channel;

after the introduction melt channel is configured with

pins, mixing shafts, labyrinth,

variable section, for instance expansion zone.

34) Apparatus for manufacturing extruded profiles of different plastic components in systems consisting of extruder(s), mould and calibrating- and cooling line, wherein the device having an arrangement to divert the melt stream

of at least one extruder in the mould into at least two melt channels and having an injector, charging pipe, nozzle, mixing head, porous sinter metal, pump-nozzle, charging device or spraying unit reaching into the melt channel, for introducing additives for instance hardener, dyes, gas processors, softener, filler, reinforcement a/o. into the melt stream and having a regulator for the pressure of the additives connected to a pressure sensor located the melt stream and advantageously having a device for pulsation and optional a throttle valve is located at the melt stream at the inlet, and having a mixer in the melt stream after the introduction of the additives, for instance pins, mixing shafts and labyrinth and having a variable channel sections for application of shear forces according to the acceleration of the melt for mixing the components having different properties, specific weight to the original material and variable sections of the channel as there are expansion zones and having junctions inside the mould to unify the melt streams to one stream and subsequently the melt channel is connected to the mould creating a profile consisting of different material components melted together in the mould and the mould is connected to the following calibrating and cooling section.

35) Apparatus according to claim 33, wherein the diversion of the melt channel, the introduction of the additives, the charging pipeline are located on a interfacing part, mounted in between the flange of the extruder and the flange of the tool.

36) Extruded plastic profile with determined section consisting of at least two components, wherein the said components are derived from at least two melt streams coming from one extruder leading to the mould in separate channels and by introducing additives to these melt streams the properties, for instance specific weight, color, hardness and structure of the matrix are different from the original properties of the extruded component.

37) Device for dosing, dosage and mixing of at least one viscous component with another viscous substance, consisting of an outer nozzle cones and an outer nozzle needle having adjustment devices for dosing or blocking of the outside flowing medium depending on the position of the nozzle needle and said  
5 nozzle needle is having a boring, wherein the outer nozzle needle is having a front chamber with the shape of a valve cone orifice or a pocket hole orifice and the said nozzle needle with boring is having an inner nozzle needle having a conical seat for blocking and each nozzle needle having a mechanism for operating the needles respectively.

38) Device consisting of a Hotrunner nozzle in moulds for injection moulding having a outside operated nozzle needle, wherein the said nozzle needle having a boring and having at least one orifice at the needle top and said orifice is in direction rectangular to the needle top at the needle seat and the said nozzle  
15 needle is having a connection to a common rail being connected to a high pressure pump supplying constant pressure to the nozzle needle independent to the position of the hot runner nozzle.

39) Device according to the claim 37 and 38, wherein the nozzle needle is  
20 having a boring and having orifices, and in the said boring another nozzle needle is located blocking the said orifices according to the activating mechanism attached to the inner nozzle needle.

40) Device according to claim 37 and 38, wherein the needle having the  
25 shape of a common rail injector and the said injector is attached to a mechanism for activation and the injector tip is shaped as a nozzle needle and advantageously forming the orifices to reach into the nozzle seat.

41) Device according to claim 39, wherein the gap between the outer nozzle needle and the inner nozzle needle is formed to act as a suction valve for the substances inside the inner nozzle needle.

5 42) Device according to claim 37 till 41, wherein the device is attached to a subsequent located statical mixing device.

43) Device according to claim 37 to 41, wherein the device is attached to a nozzle of a plasticizing unit of a injection moulding machine.

10

44) Device according to claim 37 to 41, wherein the device is attached to a the melt channel of an extruder.

**ABSTRACT**

A method introduces additives into flowing or fluidised media. The spatially predetermined position of the additives in the flowing material, also called fluid bed, is obtained by controlling the pulsating injection. The introduction and exact dosing of additives, that is hardeners, dyes, gas producers and softener for instance, into a liquid plastic stream or metal stream (10) for instance, or the fluid bed of bulk material, such as powder, granules and pellets, is carried out by means of an injector. The invention is used in melting units, in hot channel systems, in tools, components of tools and injection moulding machines, extruders, injection moulding, pelleting, burner and injection arrangements. The nozzle needle (3) of at least one nozzle (2), respectively, is variable and highly precisely moved for the introduction by means of a device and in such a way that additive (17) is dosed exactly in relation to the volume flow of the medium and that a pulsating stream (18, 36) is injected into the medium flowing past, by means of at least one well-aimed nozzle opening (4).

15 The additives are dosed by means of a pressure that can be variably adjusted by pulse width and pulse frequency. The desired homogenous distribution is obtained by the penetrating injection jet (37) during compounding.



The invention relates generally 2ND + LAST  
flowing or fluidised media with specific application to,  
although not necessarily limited thereto.

20

In US patent No. 4,474,717, by James W. Hendry, dated 1982, an injection of spatially predetermine position is disclosed, specifically, injection of a small portion of plastics without introducing inert gas (preloading) followed by sectional introduction of inert gas using frequencies from 4 to 100 cycle per second having a pressure of 300 – 1500 psi (2 to 10 MPa) into the continuous passing plastic material. The result is a multi layered inside foamed structure. The ~~submitted~~ <sup>present</sup>

invention expands this method by applying injection technology used in the combustion engine technology. Reaching a more intensive penetration by higher pressure (40 to 200 MPa), higher frequency (100 to 1000 Hz) and more exact dosing by controlled width of the pulses, frequency of the pulses and regulation of pressure using this technology. <sup>Various</sup> ~~Suggested~~ design<sup>s</sup> of nozzle and channels <sup>by filtering</sup> according to hydro-mechanical principles application for metal, ~~bit~~ material<sup>s</sup> and high viscous melts <sup>can be achieved</sup> ~~bulk~~ X

### State of the art concerning methods for introducing additives

The following devices and methods are subject of previous solutions:

i) EP161614, WOLTON FRANK, 1985, showing<sup>s</sup> a device for injection of certain amount of medium into the fluid stream. The adding of the additives happens by a charging pump which is activated by the flowing medium. ~~the~~ energetic mixing is not possible because of the small pressure difference.

ii) <sup>A</sup> ~~The~~ device <sup>for</sup> of adding additives into a liquid stream of high viscosity has been <sup>disclosed</sup> introduced in US 5913324, SIGNER ARNO, 1997.

By diaphragm the high shear forces of the medium with high viscosity the mixing takes place. A dosing is happening in the side stream and independent of the main stream.

iii) <sup>for</sup> A device of adding additives after the plasticising unit is shown in EP0432336, CLOUP PHILLIP, 1991.

iv) For the adding of additives after the plasticising unit the following methods are known.

a) WO89053226, HETTINGA SIEBOLT, 1988 shows,

blowing in of air.

b) US4931236, HETTINGA SIEBOLT, 1989 shows

spraying in of air/gas after the plasticising to achieve hose with foam layer.

c) DE1948454, BAYER, 1971 *shows*

Injection of chemical gas producer after plastisicing unit.

A mixing by energetic injection jet stream and pulsing dosing is not <sup>the</sup> subject of the last named inventions.

- 5     ✓) A nozzle for application of glue by pulsation is shown in US 5934521, KOIKE KATSUHIKO, 1998.

The nozzle-needle is activated by a pneumatic cylinder up and down, so that glue pours out in pulsing way. A mixing with a flowing medium passing by is not on purpose.

- 10     The pulsing adding <sup>tion</sup> of liquid and gas is state of the art in burner-<sup>systems</sup>, airless jet-<sup>systems</sup> and spraying- systems (atomizers).

The submitted invention is demarcating from these application by higher pressure of the liquid than 40 MPa and high energetic atomizing.

- 15     This pressure is not possible with the nozzles used <sup>at this time,</sup> ~~by now~~. Only by electrical activated hydraulic servo valves in common rail technology <sup>can</sup> these pulsation ~~can~~ be realized.

### SUMMARY OF THE INVENTION

- 20     a) General Description of the invention. *Remove Bold*

The basic concept of the inventive method for introducing additives consist of obtaining intensive atomizing, mixing and deep penetrating of additives into the medium stream by using high kinetic energy of the additives and exact timed pulsing and exact pulse width using appropriate injectors.

- 25     The exact dosing of the additives is obtained by regulation of the operation parameters of introduction for instance pressure, frequency, pulsing width, etc.

- 30     The state of the art of combustion engines using the "common rail" injection technology is utilized. The flexibility of this system by modifying the operation <sup>present</sup> ~~former~~ parameters is the highlight of this technology in comparison to the <sup>because</sup> ~~former~~ used mechanical operated injection methods ~~as~~ there is injection nozzle, etc. The common rail is loaded with fuel being pressurized up to 200 MPa and supplies the

injector with this constant pressure. Electronic controller activating solenoid and piezo-operated, electro-hydraulic servo-valves ~~to~~ move the nozzle needle by push rods with high precision. According to this technology exact dosing and homogenous distribution will be obtained.

- 5 The application and further development of this injection technology is subject to utilizing this improved technology for further applications as mentioned before. Furthermore detailed design and configuring of nozzles, nozzle-needles, the arrangement of orifices in position and shape as well as arrangement of injectors are <sup>aspects</sup> ~~subject~~ of this invention.

10

*Remove Red*

**b) Description and economical benefit of the present invention.**

- i) Introduction into the plastic melt stream:  
 The introduction happens after the plastisicing unit.
- 15 ii) This is for many processes listed below <sup>of advantages noted</sup> ~~of~~ advantages noted  
 Recruiting material of different properties out of one plastisicing unit, <sup>is possible</sup> ~~is possible~~  
<sup>producing</sup>
- iii) For Injection moulding systems predetermined properties like porosity, coloring are possible by one process step <sup>through</sup> ~~by~~ variable introduction. Only multi-  
 20 component injection moulding machines can ~~do~~ <sup>accomplish this</sup> today.
- iv) For extruder systems profiles <sup>can</sup> ~~will~~ be extruded with different components at predetermined sections can be foamed by diverting the plastic melt stream and introducing gas <sup>which</sup> ~~creators~~ in one side stream by an injector so that this melt  
 25 stream will expand <sup>and</sup> ~~can~~ be joined together with the material of the main stream.
- v) Plastics for sheet and tube extruders can be introduced with dyes, gas processors, <sup>and</sup> ~~softener~~ after the extruder, ~~and~~ therefore a fast change of the  
 30 material properties is possible what leads to economical flexibility in the production, <sup>process</sup>.

v.) Pelletizing systems in the nutrition can be modified by introducing flavors and additives after the extruder by injectors, so that the material does not have to go through all the screw total length.

5 v.) Chemical and process-technological systems like distillation-water-treatment plants and oil refineries.

In this regard, the introduction and dosing and the homogenous distribution of bleaching agents, solvents in circuits of cellulose, pulp and mechanical wood pulp happens according to the state of art by dosing units with subsequent mixing.

10 High shear forces are needed for the efficient mixing.

Any modification of the operation parameters as there is <sup>in the</sup> a <sup>because</sup> change of amount of additives or changing of color chemical additives will have only an effect after completing a total running through of one plastisicing circuit.

15 ~~The invention relates to a method for introducing additives into flowing medium by exact dosing and homogenous distribution.~~ <sup>IP</sup> The following application<sup>s</sup>, processes and devices ~~coming to~~ <sup>can be</sup> an economical realization<sup>ed with the invention!</sup>.

20 • Introduction, dosing and homogenous distribution of additives as there are hardener<sup>s</sup>, dyes, gas processors, softener<sup>s</sup>, reactant<sup>s</sup> into the melt stream of plastics in:

- Extrusion systems for sheets, tubes and profiles.
- Compounding systems for production and adaptation of plastics.
- Injection moulding, forming operation, preform manufacturing systems.
- Auxiliary processing, forming operation, preform manufacturing systems.

25 • Introduction, dosing and homogenous distribution of catalyze<sup>s</sup>, <sup>no</sup> reactants in flowing liquid in chemical, processing systems as well as, for instance,

30 distillation water treatment, refinery systems.

- Introducing, dosing and homogenous distribution of <sup>blowing</sup> ~~blowing~~ agents, solvents into the circuit of pulp and ground wood systems.
- Introducing, dosing and homogenous distribution into alloys and metallurgical additives as <sup>well</sup> ~~as~~ as gas processors into the metal melt flow of die casting, profile casting and continuous casting systems.
- Introducing, dosing and homogenous distribution of additives and flavor agents for palletizing, dough and noodle processing systems in the nutrition industry.
- Introducing, dosing and homogenous distribution of fuel into combustion systems.
- Introducing, dosing and homogenous distribution of dyes and solvents in airless and spraying systems.
- Introducing, dosing and homogenous distribution of additives into fluidized material like bulk and powder material, granules, pellets in plants operating fluidized bed and whirl sintering installations.

### **c) Method of introducing additives.** <sup>Remove bold</sup>

Exact dosing and homogenous distribution is utilized. The present invention relates to introducing additives for instance gas processors into the melt stream of plastics or low melting metals.

The advantage of this process is the application of light weight structures at locations of a part where it is demanded. The gas processing substance for expanding the matrix material is introduced in spatially predetermined positions. Various operation modes and combination of these can be obtained firstly by pressure differences between melt and gas processing substances and secondly by the frequency of pulsation and thirdly by the shape of the nozzle reaching into the melt channel:

### **1) Creation of foam:** <sup>Remove bold</sup>

Using high frequent <sup>cy</sup> pulsation and therefore atomizing at high pressure difference and advantages <sup>at</sup> ~~as~~ at counterflow and subsequent high acceleration of

the melt <sup>at</sup> variable sections of the melt channel. The difference of the speed of melt and additive is selected <sup>of</sup> high value.

### Macro-hollow cavities: <sup>macro bolt</sup>

- 5 The introduction happens by drop shaped dosing of the melt flow at low frequency of the pulsation and only small pressure difference in flow direction and essentially laminar streaming conditions of gas processors and melt.

### Continuous introduction:

- 10 Continuous introduction of a string of gas processors at nearly adequate flow speed of the passing medium. Small pressure difference is <sup>an</sup> of advantage.

An apparatus for injection molding of compound parts with charger, which are connected to a pump which is compressing <sup>for</sup> chemical blowing agent has been published in DE1948454 by BAYER 1971 to achieve a spatially  
15 predetermined foaming. Because of the insufficient mixing and dosing the proposed foam quality cannot be reached.

- The present invention is demarcating from the above apparatus by using injectors (combination of valve and nozzle) and pulsing injection and optionally using a continuously pressurized pipeline <sup>for</sup> "common rail" and hydro-electrical  
20 activated valves.

Because of the shaping of nozzles and channels according to hydrodynamic principles as well as regulated pressure the apparatus is different.

The solenoid is activated by electrical supply and optionally controlled by generating an arbitrary wave generator.

- 25 This leads to operation mode <sup>s</sup> like atomizing, dotation and continuous string. The selection of pressure difference and frequency of pulsation leads to a predetermined introduction of gas processors into the melt. The exact dosing and pressure regulation leads to a targeted dotation of drops into the melt resulting in a subsequent macro hollow cavity expansion.

The apparatus for introduction of gas creating substances into the highly pressurized melt consists of a nozzle in immediate connection with <sup>a</sup>servo-valve, or consists of a pump-nozzle system with a non-return-valve combination.

Especially <sup>the</sup> injection technology of combustion engineering reached a high state of art concerning the exact repeatability due to the demand of strict exhaust specification, <sup>and is especially applicable to the invention.</sup> <sup>how</sup>

The state of the art <sup>is shown by</sup>

<sup>disclosed</sup> ~~at~~ "fuel-injection valves for internal combustion engines" <sup>disclosed</sup> shown in DE2028442, 1970, by DAIMLER BENZ. The hydraulic activation of the valve push rod is regulated by a three way valve.

An "injection device" with hydro-electric activation was invented by PEUQUEOT, FR2145081, in 1971. The valve is pushed by a continuous hydraulic pressure and released by a controlled pressure loss on the backside of the push rod. In US3990422, 1973, by BENDIX CORP, the control of the hydro-electric activation has been improved by using a two circuit hydraulic system.

<sup>invention</sup> The present injectors show features which are necessary to comply with the demands of the application and specification thereof. These are <sup>pressure</sup> regulation, electro-hydraulic activation by a push rod valve and pressure controlled by a sphere valve at the high pressure circuit, which is necessary to reach the high frequency pulsation and having <sup>e</sup> the high pressure available at the nozzle needle immediately at the valve seat by a common rail system, <sup>which</sup> makes the accuracy independent of pressure and velocity differences between the gas creating substances and the melt.

The present invention relates to this high pressure technology <sup>which is</sup> to be adapted for the special condition of the introduction into the melt. The high pressure for injectors in combustion engines is needed for atomizing and distribution of the fuel in the combustion zone. The high pressure for injectors in melt introduction processes is needed to overcome the high melt pressure of about 100 to 140 MPa. Pressure of about 200 MPa can be reached by the available injectors with common rail. The continuous supply and the activation of the valves are solved with high reliability today.



became  
 An essential presupposition for running the injectors is the lubrication by the fuel. ~~Since~~ gas creating substances (water, alcohol, liquid gas) do not have substantial lubrication effect. The basic idea of the present invention is the use of two circuits applied to the standard injectors available in the market  
 5 making additional measures.

The patent JP 8170569 by NIPPON SOKEN, 1994, is showing a version of injectors for diesel engines by using a high pressurized circuit for injection and a low pressurized circuit for the servo hydraulic system. The ~~present~~ <sup>invention</sup> injector ~~reaches~~ <sup>operates</sup> by separation of the hydro-electrical activation of the push rod of the valve ~~by using~~ <sup>in which</sup> standard hydraulic oil and the introduction of gas creating substances happens with a slightly lower pressure (different ~~to the~~ <sup>at</sup> JP 8170569) because of non return lock pressure ~~to prevent~~ <sup>which</sup> penetration of melt into the injector. Only the needle and seat of the valve are in touch with the non lubrication medium. These parts can be made of sintered highly wear resistant  
 10 material and are easily changeable. The electro-hydraulic servo circuit is not effected because of the separate circuit.

Further alternative solution for the injector are:

- a) Pump nozzle system with a combination of high pressure piston and spherical valves.
- 20 b) An electric activated swing system attached to a pump piston.
- c) Limits for the stroke and positioning of the inlet valve as known for airless spraying systems can be used as well. In some application <sup>it is</sup> ~~an~~ <sup>an</sup> advantage to have <sup>small</sup> ~~small~~ pressure difference between the introduced material and the melt. For this the above solution can be used.

25 The regulation and control of the introduction process having the following features:

( Optionally, the hydraulic circuit can be separated from the gas creating substances to be introduced. The pressure  $p_1$  of the medium to be introduced and the pressure  $p_2$  of the hydraulic system are regulated by a pressure limit  
 30 valve. The controller regulating the pressure depends on the melt  $p_3$ , for the hydraulic system circuit as well as the injection pressure of the introduced

*Spill lock continuous*

medium. The injector is activated by <sup>a</sup> solenoid or piezo actuator. The regulation is controlled by an "Arbitrary Wave Form Generator", known to those skilled in the art. Furthermore, the specification of hydraulic, nozzles, injectors and melt channel are described below.

- 5           The hydraulics for <sup>sp</sup> continuous production for instance extrusion, continuous casting and for part production by injection moulding and die casting are prescribed. The system for continuous production is used for extruders. Continuous charging and multiple injector assembly is preferred. The system for part production is used in injection moulding and die casting systems. Because
- 10 of the interruption after the injection a simple solution using a pressure multiplier double cylinder is offered for injection moulding systems. The hydraulic system of the existing machine having <sup>e</sup> usually a pressure of 26 MPa can be used to <sup>that</sup> bring high pressure by a pressure multiplying system. While plastification takes place, the pressure multiplier for the hydraulic system as well as for the
- 15 introducing system is loaded with hydraulic oil and gas creating substance respectively. For the dotation of the melt with concrete size and spatially predetermined position it is necessary to achieve a constant pressure difference while injection takes place. A high pressure difference leads to the destroying of the melt. The ramping of the pressure is shown in figure 9. The injection
- 20 pressure increases to the nominal pressure during the injection operation. During the injection the gas creating medium must be introduced by a higher pressure than the melt. The velocity of the melt in the gate of the mould has to be equivalent to the introduction speed of the gas creating medium. For
- 25 <sup>achieving</sup> ~~reaching~~ this feature an exact pressure regulation with electrical pressure limit and a precise activation of the hydro-electric valves is necessary. The shaping of the valve, valve seat and the smooth configuration of the melt channel according to hydrodynamic principles is important for repeatable dotation of the melt. The injectors of the "common rail technology" have the capability to fulfill these features.

*(dosage)*

The regulation of the solenoid takes place by controlling with "Arbitrary Wave Form Generator", opening and locking can be optimized by this system. Furthermore the shape of nozzle and melt channel is described.

## 5 **Examples of introducing additives.** *known well*

The present process relates to the modification of the properties (compounding) of an origin extruded material by diversion of the main stream into a side stream and introducing additives into this side stream by dosing, mixing and distribution of the original material. The kind of additives determine the properties of the plastic material of the melt. These additives are for instance additional components ~~as there are~~ <sup>such as</sup> hardener<sup>s</sup>, dyes, gas processors, softener<sup>s</sup>, filler<sup>s</sup> and reinforcements.

This process can be applied to inside melt channels of mould for extrusion as well as for injection moulding systems, by means of using at least two diverted streams of melt to reach different properties of the plastic material. Profiles produced by this process having <sup>at</sup> different properties of the material ~~on~~ spatially predetermined positions. This method saves an additional extruder to produce the additional material component. The essential advantage is<sub>x</sub> that based on the same origin material the waste disposal is not necessary, because based on the same material, the recycling results in a unique material. The additives are introduced by nozzle, injector, charging tube, mixing head, porous sinter metal, sliding pump, charger and spraying system. The following concrete application for production of profiles are subsequently shown for instance:

## 25 **PVC Window profiles.** *known well*

Sections of the profile close to the outside or inside can be insulated with the present process by using foam filling at the concerned chambers. The calipers as used for the known multiple chamber systems will be adapted with inside channels and with the present described devices. From the main melt stream, diverted material comes to the channel duct within the caliber in which by means of a metering regulation (as there are valve, throttle) the melt is fed to

carbon dioxide - 12 -

became

the device for introduction of the additives. Subsequently devices for mixing and homogenizing are placed in the channel to complete the compounding process.

Using PVC for the window profile the additive will be physical gas creators like water, carbondioxyd, alcohol, glycerin, etc. The pressure ramping in the melt

5 duct is decreasing, ~~for~~ the additives <sup>provide</sup> ~~give~~ additional gas volume. For expansion of the material a conical zone is configured according to the volume increase or ~~according to~~ the velocity increase <sup>and</sup> the additional volume comes to a expansion zone (conical increasing outlet) so that the compounded material is ~~lead~~ <sup>on</sup> to the

outside solid PVC profile shells and can be homogenous and adhesive <sup>N</sup> bound <sup>fed</sup> together. The advantage of the profiles with multi components <sup>is achieved</sup> comes by the cost effective production and the better properties of the material for heat and sound insulation (low pressure within the foam cells and therefore lower heat

transfer rates) and less cost for recycling of the waste material. As <sup>a</sup> variation, the additives can be introduced by singular dotation <sup>and</sup> leading to a profile with

15 honeycomb shaped cellular structures of high strength. These structures replacing <sup>e</sup> the necessary stiffener profiles.

(ii) **Window profiles out of Polyolefinen** <sup>Remove Bold</sup> as described above but using Polypropylen PP or Polyethylen PE, HDPE, etc.:

20 (iii) **Claddings or panel shaped coverings for outside or inside walls.**

<sup>This is</sup> More simpler than described above, <sup>m</sup> the total extruded profile with foam core and large cell structure can be obtained by one diverted material stream from the main stream to be compounded within the center of the profile. The

25 subsequent process of calibrating and cooling remains the same as before. The so obtained profiles can be used for inside cladding, mobile walls, <sup>etc</sup> and having high stiffness by using large cell striker.

(iv) **Tubes from PVC, PO** <sup>Remove Bold</sup>

Because of suitable introduction of gas creating and/or fillers, or reinforcement to the melt stream into ~~the~~ spatially predetermined locations, ~~as~~ there are intermediate layer, outside layers, etc.) <sup>a</sup>the multi component tube can be produced with simple measures. The device for compounding is attached in

5 between the flanges of extruder and mould and is supplied by the channels of the mould to modify the properties of the material. Another production process with excellent mixing of the melt consists of introducing the additives before the cellular pump. Another improvement can be installed by attaching a mixer or dynamic mixing head for homogenous compounding.

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### (v) Coloring of the outside layers of the profiles.

*produce* The introduction of dyes into the diverted melt channel makes it possible to ~~come to a fast~~ <sup>fast</sup> changeable coloring process. <sup>Remove heat</sup> Most economical, because the expensive dyes are only applied on the outside and no ~~loss~~ <sup>loss</sup> of material happens <sup>The process is</sup> by changing of the color <sup>because</sup> since the extruder <sup>does</sup> has not to be emptied completely, <sup>there</sup> therefore. The change of the color come into force immediately. Further possibilities for cost reduction can be achieved by bringing the coloring to the outside layers only.

20

### (vi) Production of sheets, insulation sheet material and compound sheets.

For system <sup>5</sup> having a large working width, the additives can be introduced into the center layer of the extruded sheet, or diverted to a melt channel similar <sup>to that</sup> as described before for the device <sup>as</sup> implemented into the calipers having the total width of the sheet. <sup>that is</sup>

25

### (vii) Apparatus for adding up a extrusion system for multi component process.

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The apparatus will be attached in between the flanges of the extruder and the mould. Following elements are included:



several known <sup>two</sup> ~~2~~ component hot runner valves the present suggested solution is having following features:

The application of the concentric positioned nozzle needles within the nozzle needle of this invention can be compared to EP 0310 914, 1987,  
5 "Process for Injection Moulding" (BATTENFELD), where a concentric positioned nozzle needle is shown in figure G.1 to 6.5. The present apparatus is demarcating from the above by using a spatially predetermined dosing of the melt while in EP 0310914 only each of the two media is switched to the mould. The present apparatus can achieve any mixing ratio in between by using the  
10 introduction of the additives by pulsation.

In US 4657496, 1987, by HUSKY, a hot runner valve for 2 components is presented with concentric positioned charging tube. By the cavities (9) and (6) within the nozzle needle, depending on the position either the one or the other component is blocked or open<sup>30</sup> respectively. The concentric shaping of the inside  
15 located nozzle makes it possible to regulate the dosing by moving the outside nozzle needle. which is controlled by the inner or outer nozzle. A mixing or a fast pulsing introduction as shown by the present apparatus is not a subject of the US 4,657,496 Patents.

The target of the present invention is not only to introduce at least two  
20 media in a concentric manner, but also to achieve a mixing, i.e., to dotate the outer medium with the inner medium.

In US 5,286,184, a variation of the concentric nozzle is published, which differs from US 4,657,496, in that it discloses the activation of the hollow shaped nozzle needle. Also in this case, there is a concentric introduction, but no mixing  
25 or dotation is the target.

The nozzle needle is activated by a push rod within the boring of the nozzle needle and is regulated by a servo-mechanic. To reach a spatially predetermined position by the dotation and/or dosing and excellent mixing the usage of a valve cone orifice VCO and a CDI injectors, as it is used in the  
30 combustion engines <sup>is an</sup> ~~of~~ advantage. The activation of the injector is known by a

hydraulic piston but also can use for the servo-mechanics for instance, <sup>a</sup> solenoid, piezo actuator, hydraulic servo, etc.

### BRIEF DESCRIPTION OF THE DRAWINGS

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The invention may take form in certain parts and arrangement of parts the preferred embodiment<sup>s</sup> of which will be described in detail and illustrated in the accompanying drawings which form a part hereof and wherein:

Figure 1 is a schematic section<sup>ed</sup> view of a valve cone orifice nozzle tip;

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Figure 2 is a section<sup>ed</sup> view similar to Figure 1 illustrating a pocket hole orifice;

Figure 3 is an elevation schematic view of a dosing and mixing arrangement;

Figure 4 is a top view of the schematic arrangement illustrated in Figure 3;

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Figure 5 is a schematic, cross-section<sup>ed</sup> view of a tube shown in Figure 3;

Figure 6 is a schematically sectioned plan view of an extruder mold reducing the cylindrical profile;

Figure 7 is an enlarged, schematically sectioned view of one of the nozzles illustrated in Figure 6;

20

Figure 8 is a schematic, sectioned plan view of an injector fitted to a tube;

Figure 9 is an enlarged view of the injection nozzle/tube arrangement illustrated in Figure 8 showing cascade distribution of the injection;

Figures 10 and 11 are schematically sectioned elevation views showing the invention applied with a plasticating screw;

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Figure 12 is a schematic elevation view showing the invention applied after the mold gate of a plasticating screw arrangement;

Figures 13 and 14 are schematic representations indicating the nozzle flow pattern;

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Figure 15 is a schematic representation of a dosing and mixing arrangement for a combustion system;

Figure 16a is a schematic representation of a mold for an extruder;



Figure 16b is an orthogonal representation of the mold depicted in Figure 16a;

Figures 17a and 17b are views similar to Figures 16a and 16b respectively;

5 Figure 18 is a schematic operating diagram for standard injectors used in the present invention;

Figure 19 is a schematic, cross-sectional elevation view of a standard, conventional injector <sup>shown</sup> ~~stated~~ with a pocket hole valve;

Figure 20 is a schematic elevation view of a prior art injector;

10 Figures 21 and 22 are views similar to Figure 20 showing modifications to the injector;

Figure 23 is a schematic elevation view showing a pump nozzle configuration;

15 Figure 24 is a view similar to Figure 23 illustrating an airless spraying system;

Figure 25 is a hydraulic circuit <sup>die</sup> ~~representation~~ for the application of the invention's injection molding and ~~die~~ casting system;

Figure 26 is a graph showing melt pressure traces as a function of time;

20 Figures 27, 28 and 29 are schematic representations of various melt channels used with the invention;

Figure 30 is a depiction of several different nozzles designated "a", "b", "c", capable of being used with the invention;

Figures 31, 32 and 33 are also depictions of nozzle configurations with orifice views designated by "b";

25 Figure 34 is a schematic elevation view depicting the device compounding a melt stream;

Figure 35 is a schematic representation of a plan view <sup>of</sup> ~~with~~ the arrangement shown in Figure 34;

30 Figures 36a and 36b are cross-sectional <sup>out</sup> ~~al~~ views of the outlet and inlet, respectively, of the arrangement shown in Figures 34 and 35 illustrating the condition of the melt therein;

Figures 37a and 37b illustrate the outlet and <sup>inlet</sup> ~~elevation~~ schematic views, respectively, of the nozzle disclosed in Figure 33; *one*

Figure 38 is an <sup>enlarged</sup> ~~elevation~~ view of a melt chamber;

Figure 39 is an <sup>schematic</sup> ~~elevation~~ view of a melt chamber similar to Figure 38;

5      Figures 40a, 40b, 40c and 40d illustrate various profile shapes capable of being produced by the subject invention;

Figure 41 is a schematic elevation view of the melt channel similar to that shown, for example, in Figures 38 and 39;

10      Figure 42 is an ~~exploded~~ <sup>in</sup> view of the injector used <sup>enlarged</sup> and the melt channel shown in Figure 41;

Figure 43 is an elevation view of a <sup>hot</sup> ~~runner~~ runner valve;

15      Figure 44 is a view of the orifice of the <sup>hot</sup> ~~runner~~ runner valve shown in Figure 43 in greater detail with the nozzle/orifice arrangement of the present invention depicted on the right side of the drawing and <sup>a</sup> prior art injector nozzle arrangement shown on the left side of the drawing;

Figures 45a, 45b and 45c ~~represent~~ <sup>schematically depict</sup>, respectively, progressively closing positions of the needle valve used in the subject invention;

Figures 46a, 46b and 46c represent enlarged views of the orifice/needle shown in Figures 45a, 45b and 45c, respectively;

20      Figures 47 and 48 are schematic elevation representations of an injector in the <sup>hot</sup> ~~runner~~ runner valve; and,

Figures 49 and 50 are elevation schematic cross-sectional <sup>ed</sup> views of the injector applied to specific melt channels.

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## DETAILED DESCRIPTION OF THE INVENTION

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Referring now to the drawings wherein the showings are for the purpose of illustrating preferred embodiments of the invention and not for the purpose of limiting the same, there is shown in Figures 1 and 2 nozzles, nozzle needles and nozzle seats.

The subsequent Figures 3 through 17 show samples for the application of the present method of introduction with exact dosing and homogenous distribution.

In figure 1 and 2 nozzles and nozzle needles and needle seats are shown.

The subsequent figures 3 to 17 show samples for the application of the present method of introduction with exact dosing and homogenous distribution.

Figure 1 shows a valve cone orifice, "VCO" nozzle tip. With (1) the nozzle needle closing the needle seat (3) located in the nozzle body (2). The small volume of the front chamber (5) is the target of the VCO. The orifices (4) are inclined about  $80^\circ$  to the axis as used in combustion engines. Other orifices (6) shown on the right side of the axis having a stepwise inclinations of  $0^\circ$  to  $75^\circ$  inclined to the axis.

In figure 2, a pocket hole orifice is shown. The larger front chamber (8) of the nozzle gives a larger volume of free drops, by means an inexact dosing. The larger chamber gives the possibility of several radial arranged orifices (6) as well as an axial positioned orifice (7).

In figure 3, an arrangement of a dosing and mixing arrangement for a flowing medium in a tube (10) is drawn with five injectors (11) reaching into the tube. The injectors are connected to a high pressure pipeline (12) containing the additive. The tank (14), the high pressure pump (9) and the common rail (15) and the leakage pipe (13) are shown.

In figure 4, an arrangement of figure 3 is shown from the top view for a extrusion system. The dosing and mixing unit is positioned in flow direction between the cellular pump (16) the mixing tube (10) and mixer (10) and the mould (22)

Figure 5 shows a sectional view of the tube (10) which is enlarged. The five nozzle tips (2) are in a radial  $72^\circ$  pattern arranged. Each nozzle tip has 7 orifices positioned in an angle of  $75^\circ$ ,  $50^\circ$ ,  $25^\circ$  and  $0^\circ$ , etc. The jet of the injection (18) gives a complete covering of the section of the medium (17). The length of the jet stream is determined by the diameter of the orifice and is usual between 0,11mm and 0,14mm.



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In figure 12 the introduction happens by the injector (11) immediately after the mould gate at the inlet of the mould (22). The advantage of a hot runner system (23) is evident. The Mixture of medium and additives is not depending on the plasticising unit (19) but determined by the introduction of additives, i.e., flexible and variable.

Figure 13 shows an airless jet stream (25). The flowing medium (39) is the streaming side air. The additive is dyes (18). The pulsation determines the coloring conditions.

5 The nozzle arrangement is shown in figure 14. At least one orifice (4) in the nozzle body (2) is directed near the axis and determines the spraying structure (18).

10 In figure 15 the dosing and mixing arrangement is shown for a combustion system. The nozzle body (2) is reaching into the combustion chamber (27) and is limited by the casing (28) of the burner zone. The combustion air is compressed by a blower (26) and the atomizing of the fuel uses the standard arrangement of orifices located on a cone. The injection jet stream (18) results in accurate dosing and mixing of the perfect combustion. (29)

15 In figures 16 a and b the application of a mould for an extruder production of profiles - for instance <sup>ok</sup> of window profiles - is arranged. The dosing and mixing <sup>ing</sup> have the purpose ~~to~~ to modify material diverted from the main stream of the melt for example with gas processors. The section shape is shown in figure 16 b. The injector (11) reaches into the side channel (30). The different material streams (31) are separated by inlet channels, calipers (32). The melt stream (17) is introduced (18) by additives and is creating foam in the side stream which 20 is transported to the chambers (33) and (34). Chambers with solid calipers creating hollow profile space is usual.

25 In figures 17a and b the introduction of additives (18) by pulsation into the side channel is shown. The arrangement is also for extrusion systems as in figure 16 as well as for pelletizing and continuous casting with mixing zone (10) applicable. Figure 17a shows the tube section (30) and the single tube (10). Figure 17b shows the lateral section of the tube (30/10). The nozzle body (2) is having 7 radial arranged orifices (4) and giving full coverage of the material section (17) by the jet streams (18) for dosing and mixing. A sequence of several jet streams (36) respectively (37) introduced in flow direction are shown 30 in 17b.

In figure 18 the total apparatus for injectors of standard design is given in the layout. The utilization of pumps (101) and (105) enable the application to be used in a continuous operation (extrusion). The circuit for the additives (103) is separated from the circuit of the hydraulic oil of the servo (104). The pressure of the circuits is regulated by an electrical<sup>ly</sup> activated presser limit valve (102, 106). The valve (112) is released by electro-hydraulic<sup>e</sup> mechanics. This mechanics consists of a solenoid (109) a spherical valve (108) and the push rod connected to the high pressure piston (110). The controller (122) is regulating the electro-hydraulic mechanics according to the information (120) given by the operation data as there is injection time/extrusion data (123) according to the pressure sensor in the melt (115) of the pressure of the additive circuit (102) and the pressure of the hydraulic oil of the servo (106).

The arbitrary wave form generator (120) creates the opening current for the electro mechanism (112). The introduction of the gas processors (117) into the melt stream (114) happens in the interface (116) part after the extruder tip (160) by a nozzle (113) reaching into the channel. For heating a heater<sup>band</sup> (159) is located around the nozzle (113).

Figure 19 shows a standard injector. This version shows a pocket hole valve (113) with a small front chamber. The valve seat (112) is locking the nozzle from the continuous pressurized circuit.

The push spring (131) increases the force resulting from the difference of force on the nozzle needle (112) and the hydraulic pressing (110). The opening is activated by the solenoid (109) which releases the sphere of the valve (108) and hydraulic oil of the servo is streaming out of the high pressure chamber (110).

Figure 20 shows an injector of the state of art. The essential features can be readily recognized. The version with the electro-hydraulic activation is extended by throttle (129) and anchor (127) and double chamber. Standard Injectors having separate inlets (126) for the servo supply and the injection supply.

Figure 21 shows a section of a modification of a standard "common rail injector". The already available two supply borings are attached to a special fitting.

Figure 22 shows the modification of a standard "common rail injector" with a second boring. The supply (132) of the hydraulic servo circuit is blocked by a pin. Additional supply is given by a boring (133) and a second fitting (126) for the servo circuit.

Figure 23 shows a pump-nozzle configuration in principle, by means of the high pressure chamber <sup>being</sup> <sup>location of the</sup> <sup>to</sup> ~~is~~ close to the nozzle <sup>located</sup> ~~located~~. The medium of the additive is supplied through a boring in the push rod (135) and the pressurizing is effected by an inlet valve (137) and an outlet-valve (139). The penetration of the melt into the injector is prevented by a sphere (137) which is pressed by a non-return-spring (138) into the valve seat. The push rod (135) is activated by a magnetic swing system (127). By stroke limit (134) the size of the pulsation is determined. The line for leakage (140) returns the overflowing medium.

Figure 24 shows the principle of an airless spraying state of the art system, applied to the present application by using a valve sphere (139) within the nozzle. The advantage of a small front chamber can be reached by a overlapping (141) of the sphere valve (134,135,140) as shown in figure 23.

Figure 25 shows a hydraulic system for part production for instance for injection moulding and die casting systems. The operation of the injector is having a twin circuit system. The pressure multiplier is connected to the basic hydraulic system of the machine (142). While processing the part there is time to load the system for injection. The pressure multiplier cylinder for the additive (143) and for the servo hydraulic oil (144) are pressurized and being regulated by the pressure limit valve (142) during the melt injection having the pressure  $p_4$ . Subsequently the chambers of the cylinders are refilled by pumps (101) for the additive and pumps (105) for the hydraulic oil.

Figure 26 showing the features of the pressure ramping y-axis in MPa (145) over the duration for the present processing. The melt pressure  $p_3$  is shown by the curve (148). The pressure of the additive  $p_1$  is shown by curve

(146), the pressure of the servo hydraulic  $p_2$  shown with the line (147). The electric potential (153) to activate the electro-hydraulic regulation is shown by the curve (149). Various wave forms can be produced and are shown by way of example as triangle (154), half sinus waves (155) at different frequencies and full sinus wave form (156) with different frequencies and phases or full sinus form (157) in different frequency or different phases (158) as well as unsymmetrical wave forms, all being produced by an arbitrary wave form generator.

Figures 27, 28 and 29 show several melt channels. Figure 27 shows a parallel melt channel (114) in flow direction positioned orifice having an interface part (116) between mould (162) and nozzle tip (160) of the barrel. This arrangement is applicable for dosage with drops (161) into the melt stream (114).

Figure 28 shows a radial multiple orifice (163) in flow and counterflow position for excellent mixing of the additives with the melt in an enlarged melt channel (114) which causes additional mixing by change of velocity. Figure 29 shows a continuous string introduction (164) into the melt channel. These method is able to process axial hollow cavities for extruded profiles.

Figures 30,31 and 32 show a nozzle with various orifices. Figure 30 shows state of the art. 30a shows a VCO valve cone orifice. Figure 30b shows radial multiple orifices. Figure 30c shows pocket hole orifices. Figure 31 shows a nozzle for flow and counterflow introduction. For introduction of additives as drops into the melt the nozzle is design according to hydrodynamic principles. For preventing atomizing, sharp edges have to be avoided. The channel profile having smooth profiles in valve cone (170) and at the nozzle profiles (171). Figure 32 shows a nozzle introducing drops sidewise in flow direction. Figure 33 shows a nozzle for atomizing in the conical seat (172) and plane seat (173) rectangular to the flow direction.

Figure 34 shows a detail of the device for compounding a melt stream. This version is implemented in calipers (53) of profile moulds (51) or for array assembly for moulds to produce sheets. The section is showing detail of figure 16 a and b. The view shows the material flow from right to left. The caliber (53)



at the inlet side is conical (64) shaped. The inlet is having a pressure sensor (63) connected to the controller (62) and supplying data <sup>to the controller</sup>

(The introduction is flow direction (55b) and counterflow (55a). The advantage of the counterflow is the ~~para~~ introduction of individually closed dosages. The introduction may optionally be caused by pulsation. For instance chicanes for the melt. The change of velocity leads to shear forces and to additional mixing respectively in the expansion zone (60).

Figure 35 shows the top view of figure 34 and the relevant numbers are the same. Note the narrow section in the melt channel.

10 In figures 36a and <sup>36</sup> b the section of the inlet and outlet is shown related to the device in figures 34 and 35. Figure 36b shows the inlet in a sectional view.

Figures 37a and 37b show the version of the invention as it is in figure 33a and 33b but for simple foamed profiles as there are claddings with integrated insulation, panels and tubes. Reference numbers are the same as in figure 33.

Figure 38 shows a version of melt channel before the distribution chamber of the mould. Two inlet cones (64), (65) and the center inlets (66) <sup>provide</sup> give a twin chamber <sup>of</sup> the melt.

Figure 39 shows a version of melt channel design with central inlet of the side channel and a concentrically (twin) introduction of additives and subsequent merging of the melt at spatially predetermined locations of the profile. The melt channel is crossing the main channel (67) in the center of the surrounded flow.

<sup>shows a</sup> Figure 40 <sup>a</sup> showing a rectangular profile, 40b circle, tube profile, 40c <sup>shows a</sup> elliptic profile, and 40d rounded rectangular profile. Several profile shapes with multiple components are shown for instance in figures 33, 38, 39 and 41 as being produced as simple tubular profiles.

Figure 41 sketches a device with an add up for existing extrusion systems and can be modified for multi-component operation. For referencee, (68) is the flange of the melt channel (69) and is the flange of the extruder, while (70) is the interface part for adding up and (71) is the melt channel with through put.

Figure 42 shows the device in Fig. 41 in detail. The device is made out of a disc (70) and attached between flanges (68) and (69). The disc has injectors for introduction of the additives as well as diaphragms (72) to divert the melt channel. The tube (72) with attached planes for the hollow calipers is shown in principle.

In figures 43 to 46, hot runner valves for injection moulding systems are shown.

In figure 44, a device in accordance with the invention is compared to a the state of art device.

Figures 45A to 45C show the progressive activation of the needle tip and figures 46A to 46C correspond to figures 45A to 45C, respectively, and show the needle tip in detail.

Figure 47 shows the version of the invention with high frequency pulsing (CDI Injector)

Figure 48 shows the integration of CDI Injectors in the hot runner valve.

Figure 49 shows the arrangement of a mixing and dosing head for example in the melt channel of the plasticising unit of an injection moulding machine or an extruder.

Figure 50 shows an arrangement of a twin unit in counterflow used for liquid/liquid mixing as well as for extruders with a subsequent static mixer.

Figure 43 shows a device for mixing and dosing and dosage. The inner nozzle needle (82) is activated by the adjusting device (93) and is in the shape of the seat (83) for a pocket hole orifice or a valve cone orifice. This insert also is part of the outer nozzle needle and shaped to be attached to the actuator piston (90). The supply of the additive happens by the boring (85) and is again attached to the interface (91). The viscous medium is supplied by the channel (89) and passes between the outer nozzle (81) and the supply tube (94,) for instance a hot runner valve a plasticising unit or a melt channel of an extruder to the final destination.

In Figure 44 the nozzle beneath "Prior Art" shows the version of a conventional inner nozzle needle as a push rod (84), as well as the inner nozzle seat, as well as the outer nozzle (94), or both according to the position of the

push rod (84) for opening or locking. The outer nozzle needle is moved and regulated according to the supply of the outer medium. In Figure 44 the present device is shown and has a nozzle insert (83) as shown in the figure as a valve cone (VCO). The orifices of the inner nozzle (83) are completely covered when inside needle (82) is locked. The inner substance is supplied between the nozzle needle (82) and the valve cone orifice (83) and is introduced in the inlet to the outer medium (89). According to the position of the inner nozzle (82) and the pulsation, the atomizing of the introduced substance (85) into the outer medium (89) occurs. The conical shaped outer nozzle needle (83), being at the same function for the inner nozzle needle is locking the orifices of the nozzle seat of the hot runner (94) of the plastisicing unit (95) or of the melt channel of an (97), and regulates the opening according to the demanded volume flow and the introduction of the two media (92).

In figure 45A the open position for introducing the outer medium is shown. The outer nozzle needle (81) is open. The inner nozzle (82) is closed. The substance (85) cannot penetrate. In figure 45B the inner nozzle needle (82) is open and gives space for the valve cone orifices (83) and the inner substance (85) is introducing to the outer medium (92). In figure 45C the inner nozzle needle (82), as well as the outer nozzle needle (83) is closed.

Figures 46A , 46B, 46C are corresponding to figures 45A, 45B, 45C but show enlarged details.

Figure 47 shows the combination of a CDI injector (88) in a nozzle seat as cone valve/pocket hole nozzle (87), having the function of the nozzle needle in the needle seat of the melt channel and closing the valve seat of the hot runner valve (94). The CDI injector is activated by the position device (93). The inner  
 5 nozzle needle is activated by a solenoid/hydraulic or a piezo/hydraulic servo. The supply of the substance happens through the fitting (91). The melt is supplied by the channel (89).

Figure 48 is showing details of figure 46 and differs by the melt channel (89) attached as a separate insert (87).

10 Figure 49 shows the arrangement of a mixing and dosing head (95) inside the nozzle tip of the plastisizing unit (96) of an injection moulding system. The insert (87) reaches into the mixing head (95) and the outer nozzle (81) and at the same time as the insert (87) regulates the flow of the melt (89).

Figure 50 shows the dosing and mixing head (98) in a tube for instance in  
 15 a tube as liquid/liquid mixer of a melt channel of a extrusion system (99). The inserts (87a, 87b) reach into the conical nozzle seat of the mixer and modify the outer nozzle needle (81) according to the position of the volume flow of the melt (89). The supply happens by a charging device (97) directing the melt into the conical valve seat. The additional mixing occurs by arranging the mixing heads  
 20 in a counter flow to have counter impact on the media flow. Optionally, this arrangement can have four media which can be mixed together. Optionally, a static mixer can be attached subsequent to the mixing and dosing device.

Indexing of reference numbers:

25	1. Nozzle needle precisely moved	87. Valve cone orifice, Pocket hole orifice
	2. Nozzle body	88. Common rail injector (CDI injector)
	3. Nozzle needle seat	89. Supply channel for melt stream
	4. Plane plurality of orifice arrangement	
30	5. Cavity at valve cone orifice VCO	
	6. Radial plurality of orifice arrangement	